RADIO CONTROL MANUAL

MAP TECHNICAL PUBLICATION

RADIO CONTROL MANUAL

RADIO CONTROL MANUAL contains something for every R/C aircraft enthusiast whether he be a single channel flier, avid multi competition enthusiast or scale modeller. If you are looking for a particular piece of equipment or a model to suit your special needs, then you will be sure to find all the answers you require in the 40 pages of tabulated equipment and model kit data which have been painstakingly compiled from information gleaned from all over the world and incorporated in a survey which covers every piece of R/C equipment for which information is available. For single channel fliers, noted expert Ken Willard explains the techniques of single channel aerobatics and leads the beginner through those difficult first attempts. Avid multi competition flyer Peter Waters introduces would-be multi pilots to the art and goes on to explain the secrets of multi competition flying through the F.A.I. aerobatic pattern. Those about to plunge into the high realm of proportional control may whet their appetites for this kind of flying as Geoffrey D. Pike takes them on a course of dual instruction. Radio Control Manual is indeed an invaluable reference source and one which should not be missing from any R/C enthusiast's private library.

A MODEL AERONAUTICAL
PRESS PRODUCTION

Publishers of
RADIO CONTROL MODELS
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16/-

Radio Tech. 12$\frac{50}{ng}$

RADIO CONTROL MANUAL

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and Tony Dowdeswell

MODEL AERONAUTICAL PRESS LTD.
13-35 BRIDGE STREET HEMEL HEMPSTEAD, HERTS

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Cover Plate

No radio control modeller can fail to be enthused at the sight of the magnificent scale D.H.2 depicted on the dust cover. Built by Robert Carlisle, Norfolk, Nebraska, U.S.A., the model spans 60 in. and weighs 7½ lb. It is powered by a Kyowa ·45 motor and is equipped with Orbit 10 radio. Rockets actually fire. Photo by Dick Stouffer.

Trade Distributors

ARGUS PRESS LIMITED
8/10 TEMPLE AVENUE, LONDON, E.C.4

Printed in Great Britain by

THE GARDEN CITY PRESS LIMITED
PIXMORE AVENUE, LETCHWORTH, HERTS.

INTRODUCTION

In producing this, the first M.A.P. Radio-Control Manual, our object has been to present the latest available information on every aspect of Radio-Control, in a form in which it will be readily absorbed and understood by the reader, who has no technical radio knowledge.

With such an enormous field to cover and such a wide variation of previous knowledge among our readers, the task of making this Manual acceptable to you all has not been easy. But of one thing we are certain; if you are interested in any phase of the hobby of building and flying radio-controlled model aircraft there will be much of interest in this book for you.

It deals with all types of equipment from the simplest single channel outfit to the most up-to-date and sophisticated proportional multi-control apparatus. There are vital statistics of typical models for engine sizes from 0·010 cu. in. to 0·61 cu. in. capacity. The articles by leading radio-control pilots giving the benefits of their personal experience are a valuable addition to a book that already contains a wealth of technical detail.

Our thanks are due to those manufacturers who helped in the compilation of this Manual by sending us details of their products, and our contributors who added their own especial and personal material to that gathered by our staff writers.

Henry J. Nicholls

Typifying the tremendous challenge and pleasure of radio control today is this picture of Peter Anderson, Newark, seen bringing his 72 in. span Cessna 172 scale model into final approach at the 1964 British National Championships. Appreciative spectators look on perhaps wishing themselves into the pilot's shoes.

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THE YEAR IN RETROSPECT

Typical of the achievements made possible by modern radio control is this huge scale Avro Shackleton M.R.3 by David Walker. In each of the four nacelles is a K. & B·19 motor and the model is equipped with F. & M. 10 channel radio. For many years the four engined scale radio control model was considered impossible.

The year 1964–5 has been an eventful year in radio control and has seen some significant changes.

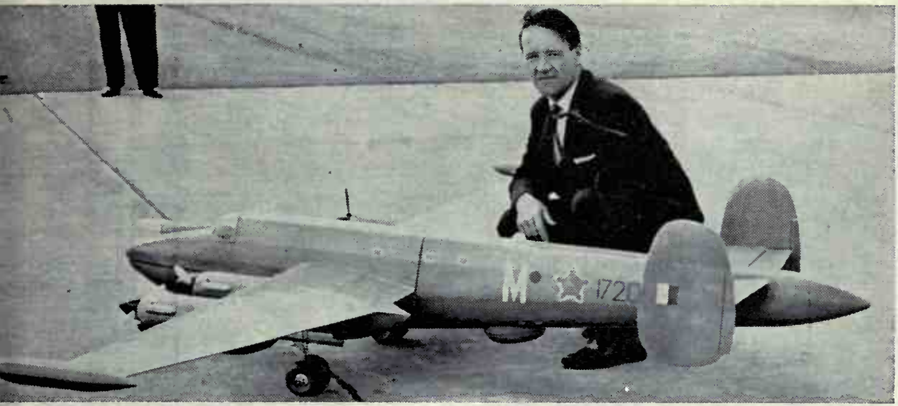
Amongst the world's leading competition fliers the ascendancy of proportional equipment is now acknowledged and there is no question that for the smooth flying now essential to gain a leading place amongst the world's best, proportional is a must.

At the same time it is interesting to note that the types of equipment that have found favour with the really keen competition fliers, especially those who are members of the International Circus, are not necessarily those which have produced the most acceptable results in the hands of sport fliers or those who fly successfully in regional and national competitions. The more sophisticated systems based on a digital technique with closed-loop feed-back servos are not necessarily as good value for the club flier as the simpler systems without feed-back servos and employing an analog system of transmitting information. Another difference in approach is manifest in the control system. For sport flying, single stick seems to find favour, but many competition fliers insist that a two stick system is essential.

The actual systems are dealt with in detail in Chapter V, and it suffices here to say that the past season has seen the rise to acceptancy for the proportional systems that had been anticipated by the many who saw it used for the first time at the World Championship at Genk in 1963, and which had been forecast by the real father of proportional control Dr. Walter Good of the DCRC Club in Washington D.C. whose T.T.P.W. was the first successful proportional system ever to have been flown, and which had been used in one form or another by the members of his Club for years before any attempt was made to produce an equivalent commercial system.

Proportional has, therefore, very definitely come to stay and although its inevitably high cost will place it beyond the reach of the sport flier, for the man who takes his competition flying really seriously it now appears to be essential.

The standard multi-channel reed-discriminator equipment is now acknowledged to have reached a state of development where the quality equipments are as reliable as they can be. More and more Club flying fields see members flying nothing but ten



channel superhet equipped models and full advantage is taken of the available spot frequencies within the band to allow several models to be flown at the same time thus giving a greater share of "air-time" to everybody. Some Clubs have, of necessity, outlawed the super-regen receiver altogether, and although this may at first seem to be an unhappily restrictive practice it is, in fact, the only practical approach. One doesn't want to drive forty miles to an airfield with two hundred pound's worth of equipment on a Sunday morning when every hour is precious to be limited to two or maybe three flights because only one model can be in the air at one time when a super-regen is in use. This has been a significant change in Club flying habits during the past year or two.

Multi model design does not seem to have advanced very much and there has not been any significant change in aerodynamic layout during the season, although new constructional methods are becoming established. Low-wing and shoulder-wing models share the honours and it is a happy thought that many of them are better looking and a little nearer to the "real thing" than they were a year or two ago. Some, are in fact, really handsome, and the standard of finish of British models at last shows signs of catching up with the Americans whose radio models have for years been the envy of those of us who have been fortunate enough to go over to see them.

One contributory factor to the improved finish on models has been the availability of fuel-proof finishes such as Hobby-Poxy in the U.S.A. and International's Polyurethane in the U.K. The latter is notable for its great ease of application with a brush and the finish obtainable is certainly superior in every way. No doped finish covered with a fuel proofer can hope to compete with these more modern materials and there is no longer any excuse for that "snowcrete and varnish" type of surface that marred so many models in the past. A poor finish is now a sign of either laziness or an inability to accept the inevitable.

At the lower end of the scale of equipment the past two years have seen the final demise of the carrier wave single channel set, the tone-modulated super-regen all-transistor receiver now being the only one retaining any popularity. It is now a really reliable piece of equipment.

Glass fibre and expanded polystrene have become widely accepted as time saving modelling materials. Here are two expanded polystrene wing cores, which, when covered with balsa or thin veneer provide a tremendously strong wing. Special adhesive is required.

Where there *has* been a great improvement has been in the design of the smaller model for single channel, many of which are now powered with engines as small as the 049 glow motors with a resulting first class performance. Another significant trend has been in the introduction of new materials and related new constructional methods in R/C models. Fibreglass fuselages and wings made of expanded polystyrene skinned over with thin sheet balsa are now much in evidence, and although models using these constructional methods are invariably heavier than those built of the conventional balsa wood, the greater speed and ease of construction confer advantages which outweigh the disadvantages.

Commercial fibre-glass fuselages are available but commercial polystyrene wings are only just beginning to become available in G.B. whereas they have been freely obtainable in the U.S.A. for a long time. It was in recognition of the fact that these components would inevitably be used by a proportion of competitors in National and International competitions that the U.S.A. proposed to the C.I.A.M. of the F.A.I. in November 1964 that the rule regarding the "builder of the model" should be amended to permit ready-made components of this nature to be employed. The proposal was adopted and it seems inevitable that we shall see partly "pre-fabbed" models at future World Championships, much as this may be unacceptable to the diehards to the hobby.

Scale modellers, those aristocrats of the modelling world, are now taking to R/C with some very rewarding results. The standard of the Scale R/C entries at the Nationals was certainly higher last year than ever before and this shows every promise of becoming the ultimate in modelling.

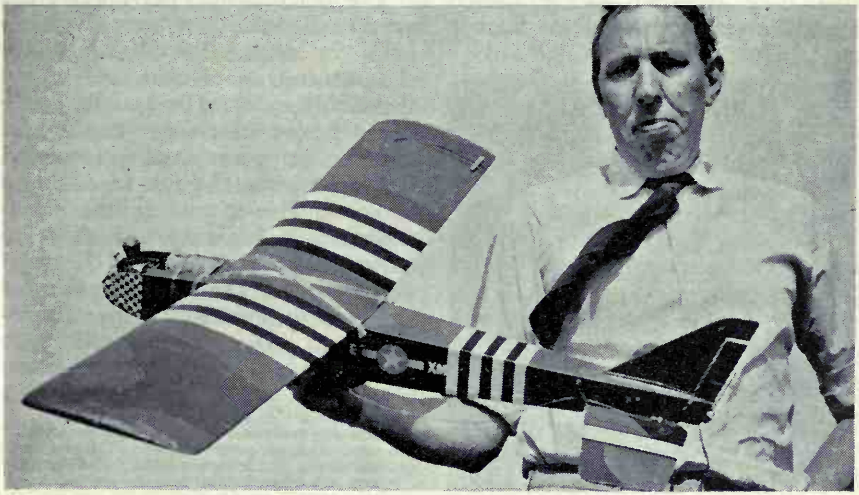
It is, perhaps, significant that most scale modellers are very definitely model builders first and interested in radio only as a means to an end. To enable them to fly their models under control.

There is a very real difference in the attitude of mind towards his hobby between the Scale man and the stunt or aerobatic flier who now looks upon ready-made components such as fibre-glass fuselages and polystyrene wings as quite acceptable even in a contest model which in every other category of modelling must have been completely built by the modeller himself.

There is certainly nothing so satisfying to watch as a flying scale model under radio control and there will undoubtedly be great developments in this field in the future.

Finally what of the standard of flying and competition flying conditions during the past year? If there *has* been a significant improvement in flying standards this has probably been due as much to the introduction of the new equipment as to any measurable rise in the standard of the pilot's skill. At National and International competitions the one feature of the competitors' flying that has shown some improvement, has been in the presentation of the pattern of manoeuvres to the judges. There was, of course, plenty of room for such improvement as even at World Championships one has seen far too many pilots literally throwing points away by performing manoeuvres in positions relative to the judges which were almost calculated to earn a minimum of marks. Presentation certainly has improved but it is still by no means perfect and it can safely be said that any National Team in a World Championship that concentrates mainly on presentation will stand a good chance of winning at least the Team award.

The past season has seen many improvements in the art of flying Radio control. We all hope that such development may continue and that the basis of International competition in this, the highest manifestation of the art, may be broadened until it becomes as representative as the other branches of our world-wide hobby.



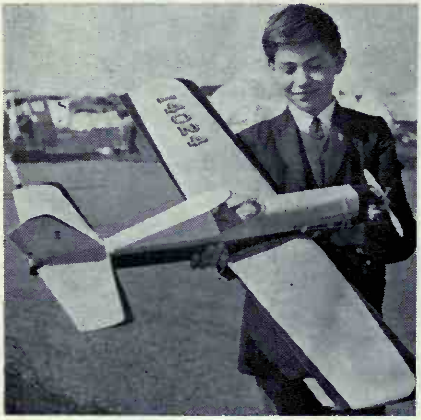
Typical of modern, high performance single channel aerobatic models is the A.P.S. Baz Bomb, seen here with designer Basil Morley. Near zero-zero trim and high speed require pilot experience and nerve.

SINGLE CHANNEL CONTROL SYSTEMS

Reliability of modern single channel radio equipment has resulted in much more attractive models, typified by this Cessna-ish "Cardinal" at right. Inverted power plant, wheel pants and sleek appearance make it a model anyone can be proud of.

Single-channel radio flying presents a challenge all its own, different entirely from multi, calling for different techniques, and to many modellers having an appeal that the more complicated and sophisticated multi systems do not have.

The modern conception of an aerobatic single-channel model is accepted as being a high- or shoulder-wing model, most probably with a high powered 049 or 09 glowplug motor such as the TD's with a medium wing loading and high flying speed. Wing area for these models would be around 150/300 sq. in. with very little dihedral. Wing section would be semi-symmetrical. Such a model is by no means a single-channel trainer but as near to being fully aerobatic as such a model can be.

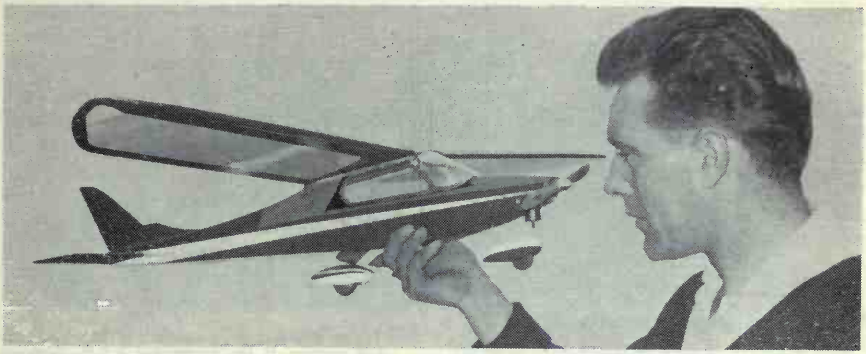


Low wing models are no longer considered taboo for single channel control systems. This attractive machine by M. Emery, Esher M.A.C., performs well with only minimal dihedral.

For the beginner, a larger model, with a Clark Y type of section, more dihedral, inbuilt stability, and practically no aerobatic capacity is a better proposition. A popular engine size for this type of design is between 0·09 and 0·19 cu. in. (1·5–3·5 ccs) and glow-plug motors are more popular than diesels.

There are many excellent and well tried designs available in kit form as well as on plans. The selection is wide and there is no need for an incorrect choice.

The tables on pages 144-148 gives the suggested dimensions and characteristics for average models for single-channel and all capacities of engine from 0·010 cu. in. to 0·19 cu. in. Study these before choosing your model either in kit or plan form and you will find them a useful guide in making a choice suitable to your ability. If you really are a beginner and about to embark on your very first R/C model don't be too ambitious. Remember success is the greatest spur to advancement and you will be most likely to succeed with a very simple model



suited to your stage of development. For the absolute beginner a kit model is better than a plan model, as a good kit ensures that the aerodynamic layout of the original design will be correctly built into the airframe, *i.e.* the incidences will be correct and there will be indications on the kit plan for the correct degrees of sidethrust and downthrust on the engine. With the modern kit with precut parts, these dimensions are more easily maintained than when building to a plan unless you are expert model builder.

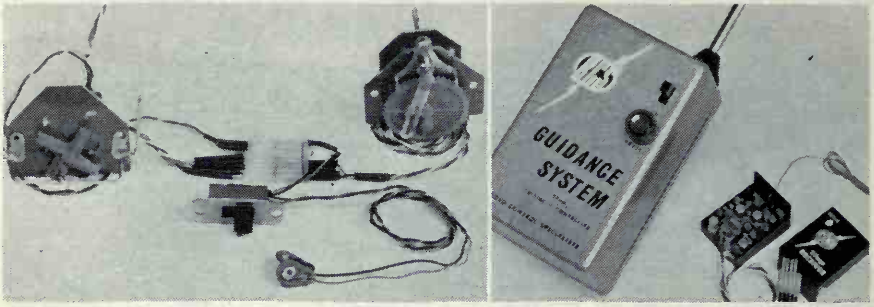
Having chosen your model you must consider the equipment. Today there is a wide choice but practically all the available good equipments have certain characteristics in common.

In receivers the carrier wave set is dead. Every set today is tone modulated and nearly all are all-transistor super-regenerative circuits with a high degree of sensitivity. Most are relayless.

The receiver is fundamentally a switching device which on receipt of a signal from the transmitter amplifies the incoming impulse until at the output stage of the receiver the current developed is strong enough to operate either a relay, or in the case of a relayless set, the escapement direct. A tone-modulated receiver has its circuit so arranged that it does not respond to a pure radio frequency signal, *i.e.* a carrier, but only to one on to which a tone or audio signal has been superimposed. See diagram on page 14. The block diagram shows the progress of the signal through the receiver and escapement in explanation of this.

The choice of ready-made single-channel receivers is wide and it is good practice to buy your equipment from a source offering the widest possible selection as well as advice and service based on the experience of customers who have already tried it out thoroughly.

Enterprise in single channel design is displayed here by K. Stokes, who created his "Bonzar" for twin ducted fan power with twin Cox 0·049 motors. Jet pods are made from fibre-glass and wing is of all sheet construction. Uses simple sequential escapement and relayless receiver.



Typical of todays single channel, all transistor control systems, is the lightweight R.C.S. Guidance System Mk.II. At left is a ready wired escapement harness for the Guidance System supplied by R.C.S. as an extra.

The basic requirements for a single channel set are:

1. Good sensitivity.
2. Stability and freedom from unwanted internal oscillations.
3. Freedom from swamping.
4. Low current drain in the "signal-off" condition (10 mA or under). (Normally referred to as the standing current.)
5. Sufficient current carrying capacity in the last stage to operate the escapement or the servo you wish to use in the case of the relayless set.

Sensitivity is not easy to measure but is generally given by the makers in terms of microvolts. This represents the strength of the voltage generated in the aerial which is the minimum to which the receiver will respond. That means that a receiver with a sensitivity of 2 microvolts (which is extremely sensitive) is five times as responsive as one with a sensitivity of 10 microvolts. It does not mean, however, that with a given transmitter the one receiver will have five times the range of the other. Rather the range ratio would be of the order of five which is approximately 2½:1 oversimplification but will serve to make the point.

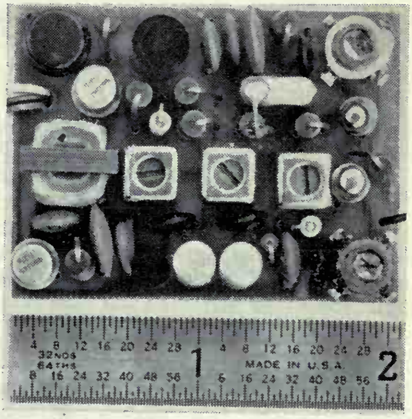
A receiver with a sensitivity of the order of 4–6 microvolts working with a transmitter with an output into the aerial of 150 milliwatts, will, when properly in tune, have a range exceeding a quarter of a mile on the ground and over 1 mile in the air. A range, in fact, that will enable you to fly a single-channel model out of sight under control.

Super-regenerative circuits are subject to their own inherent instabilities one of which is the generation of oscillations that render the receiver completely inoperative. Evidence of this condition is readily recognised through high frequency escapement chatter. A receiver that has this fault should always be returned to the makers for their attention as the only cure is the change of certain components, the identification and revaluation of which are beyond the scope of anyone but an expert.

The receiver should also be capable of continuing to work at a voltage below the recommended value. For example if the recommended voltage is 9V it should certainly continue to work down to 7V otherwise you will not be using even the normal half-life of your batteries. A 3V receiver should similarly continue to work at 2·5V or even just below this figure.

Swamping is a very difficult fault to eradicate and is, like spurious oscillation, prevalent in super-regenerative receivers. The symptom is that having once received a signal from the transmitter the receiver "locks on," the escapement holds in, and it remains in this condition until the receiver is switched off and on again. This only happens at very short range from the transmitter and it has the devastating effect of spinning a model in under full rudder when it is flown in too close to the Tx. aerial. Once again the only cure for this is to return the receiver to the makers although in our own experience even this has not always resulted in a cure being effected.

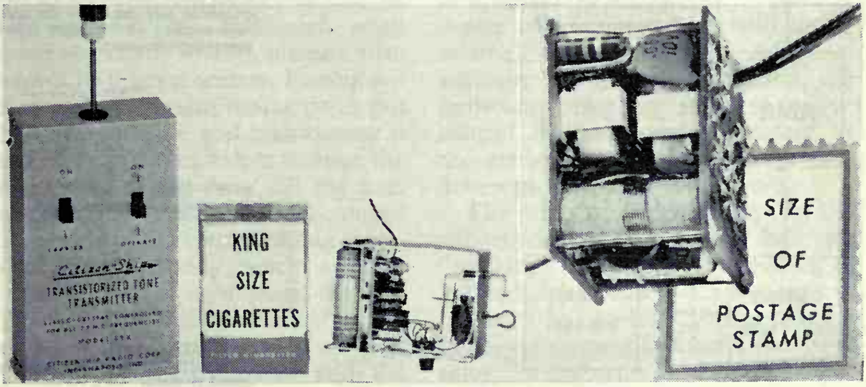
Low current drain is not very important in the standing or "no-signal" condition except that some modellers are so wary of switches and their unreliability, that in very small models such as those powered by 0·010 and 0·020 engines they have no switches at all and they can leave the receiver switched on all day when out flying in the knowledge that the battery drain will be negligible if it is under 10 mA. Receiver batteries are designed to deal with currents of the order of 300 mA and 10 mA is a mere trickle.



Although superhet receivers have not received wide acceptance by single channel enthusiasts, the Citizenship RSH superhet, shown here exactly full size, is indicative of the probable trend of single channel R/C.

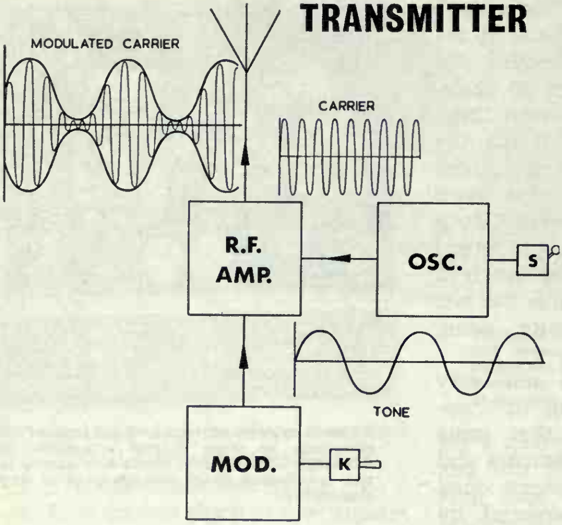
So much then for the requirements in a receiver. On pages 20 to 25 you will find full technical information on most available receivers, from which you should certainly be able to make a choice suited to your purpose.

Single-channel transmitters are mostly all-transistor these days, working on voltages varying from 6 to 14V. All have loaded aerials, some base and some centre loaded. The advantages claimed for the two types are indeterminate and the claims for the superiority of either type often without



Manufacturers are turning their attention to complete, ready to install systems. This single channel system by Citizenship shows receiver, harness and battery complement on frame ready for installation. At right is the smallest current production receiver, the Citizenship M.D.L., no larger than a postage stamp.

TRANSMITTER


MODULATED CARRIER
CARRIER
R.F. AMP.
OSC.
S
TONE
MOD.
K

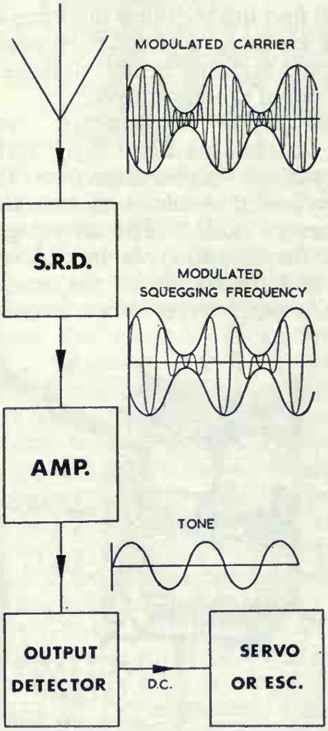
OSC.—Radio frequency oscillator or R.F. generator. Frequency is 27 megacycles per second. S represents the on-off switch. This oscillator produces the "carrier" wave.

MOD.—Modulator or audio frequency generator. Produces the "tone" of 350-700 cycles per second. In exceptional cases "tone" may be higher.

R.F. AMP.—Amplifier stage which increases strength of signal before feeding the modulated carrier to the aerial.

Simplified block diagram showing the working principles of the single channel system with super-regenerative receiver

RECEIVER


MODULATED CARRIER
S.R.D.
MODULATED SQUEGGING FREQUENCY
AMP.
TONE
OUTPUT DETECTOR
D.C.
SERVO OR ESC.

S.R.D.—Super regenerative detector which rectifies out the R.F. frequency and passes on the tone superimposed on the super regen squegging frequency.

AMP.—Increases signal strength and passes on to output stage.

OUTPUT—Converts the tone to a D.C. current to operate the escapement or servo.

sound foundation. Both types of aerial work well.

Commercial transmitters generally have two tuning controls. One that tunes the RF oscillator circuit to the desired frequency and one that matches the aerial to the output circuit so as to achieve maximum transfer of energy into the aerial. Whereas most modellers are quite capable of tuning their transmitters to a frequency somewhere in the middle of the permitted band, 26·995–27·45 Mc/s., they are advised not to try any adjustment of the aerial coupling circuit as to do this satisfactorily requires equipment not generally possessed by the modeller.

Frequency tuning of the transmitter is most easily done by using a monitor which gives an audible signal of the transmitted tone, the monitor having first been tuned to a crystal controlled transmitter of the required frequency.

Here is an example of how to use a monitor to tune your transmitter to maximum output at a given frequency. We will assume that it is crystal controlled.

First key the transmitter and switch on the monitor. You will hear the transmitted tone. Tune the monitor for maximum response, *i.e.* the loudest tone. If the monitor is directional turn it to get the *maximum* response as at this point your deliberations will be least affected by accidental small movements of the monitor with respect to the transmitter. Having got near to the optimum tuning point put the monitor down and maintaining it in one position get a helper to move the transmitter slowly away, all the time operating the monitor tuning control either side of the correct tuning point. You will eventually reach a point where the signal is so weak that the "bracket" through which you can turn the monitor tuning control is reduced to a few degrees and the tuning will be very sharp. Tune carefully to the peak response. At this point leave the monitor switched on and now tune the transmitter (leaving it exactly where it is on the bench or other support) until you obtain a maximum signal at the monitor.

You now have your monitor accurately tuned to your transmitter frequency and your transmitter tuned for maximum output at that frequency. Note that we have not suggested any adjustment of the aerial coupling circuit as although adjustment of this *can* be done by the somewhat crude "monitor system" it is best, as already suggested, to have this done by the makers.

If your transmitter is not crystal controlled carry out the above procedure but first tune the monitor to a crystal controlled transmitter of the desired frequency, then leave the monitor tuned thus, making all tuning adjustments at the transmitter.

Details of most transmitters will be found on pages 26, 27, 28, 29. You will note figures for output are not given. This is because figures given by manufacturers are not truly comparable.

Having considered receivers and transmitters we must now turn our attention to escapements and servos for single-channel operation. An escapement is an electro mechanical device consisting of a solenoid acting as an electro-magnet, which moves an armature by magnetic attraction, the armature being so arranged as to control the rotational movement of the actuator spindle through a predetermined series of movements.

The simplest escapement is the rubber driven type which has two "working" positions corresponding to left and right rudder with two neutral positions in between. This is called a 2P2N escapement and has a two-pawl rotor. To maintain either left or right rudder the transmitter button must be held on and as soon as it is released the escapement will go on to the next neutral position which will be maintained until a further signal is received.

The same type of escapement fitted with a four-pawl rotor has a different series of movements in which the receipt of successive signals from the transmitter will cause the rotor to move through only 90 degrees each time thus enabling four positions to be maintained without the necessity for holding on the transmitter signal, *i.e.* a short signal from the transmitter will suffice to rotate the escapement rotor to the next position where it will remain until another short pulse is transmitted. This is a 4P type. This is seldom used in aircraft now as it is not "self-neutralising." This means that failure of either the transmitter or the receiver does not ensure the return of the rudder to one of the two neutral positions as is the case with the 2P2N unit. 4P escapements find an application in boat work where the lack of self-neutralising need not be nearly so disastrous as in the case of aircraft.

All 2P2N and 4P escapements are sequential, *i.e.* their movements always occur in the same sequence on receipt of a number of transmitted signals. Thus, if the last position of the escapement was left rudder and you want left rudder again, you must go through right rudder and two neutrals to get there.

The second type of escapement we must consider is the compound. This has a different pawl arrangement which allows any desired position of the rotor to be selected by means of a coded signal from the transmitter. In addition to giving rudder control the compound also gives engine speed control via a second escapement at two speeds (generally simply fast and slow), by means of a further coded signal from the transmitter.

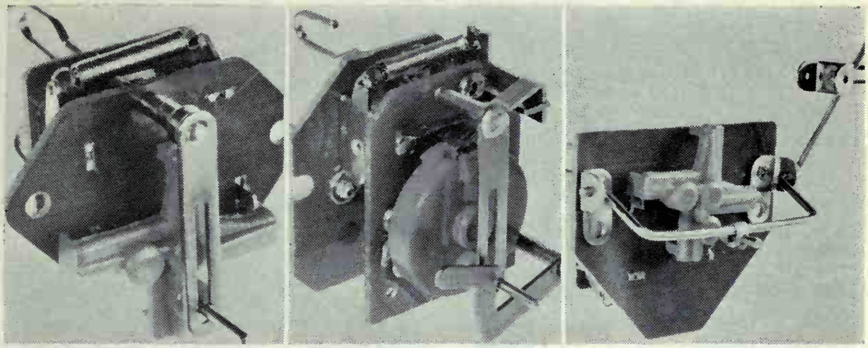
The code is very simple: For right rudder simply press the transmitter button once and hold. Right rudder will be maintained as long as the transmitter signal is maintained. On release of the transmitter button the escapement will return to neutral. Left rudder is obtained by pressing the transmitter button twice and holding the second press, *i.e.* you give one short and one maintained signal. On release the escapement again returns to the same neutral.

To change engine speed it is necessary to transmit a *very short* pulse, generally referred to as a "quick blip." The best way to achieve the necessary short duration of the transmitted pulse is to hit the transmitter button sharply with the ball of the thumb.

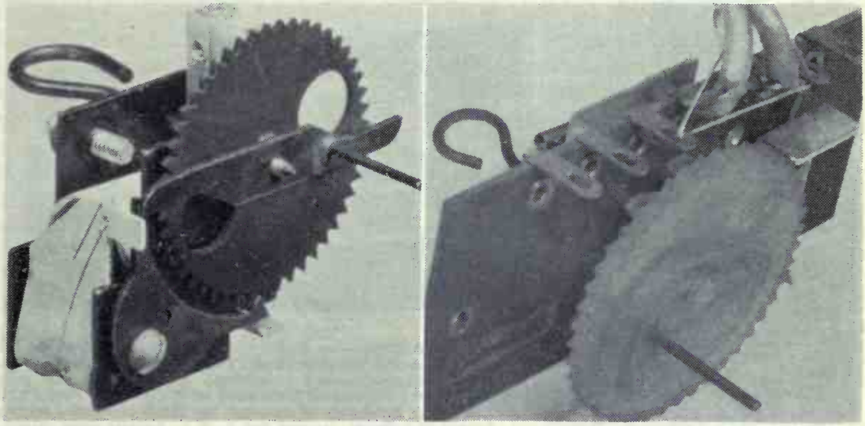
Lastly we have the Super Compound Escapement which is a refinement of the compound in which the addition of a further mechanical linkage designed to operate in one of the neutral positions, can be used to obtain some degree of elevator control, generally "UP."

As regards the compatibility of any escapement with a receiver, it can be simply stated that any escapement will work with any receiver that has a relay. In the case of the relayless receiver the only requirement is that the operating current of the escapement shall be within the capacity of the receiver's last stage, and that they shall both operate at the same voltage. Thus an escapement whose current consumption is 300 mA at 3V will work with any 3V receiver whose last stage has a current capacity equal to or in excess of 300 mA. But if the escapement needs 4½V to produce a current of 300 mA and it is to be used in conjunction with a 3V receiver, then a two battery circuit must be used with separate power supplies for each.

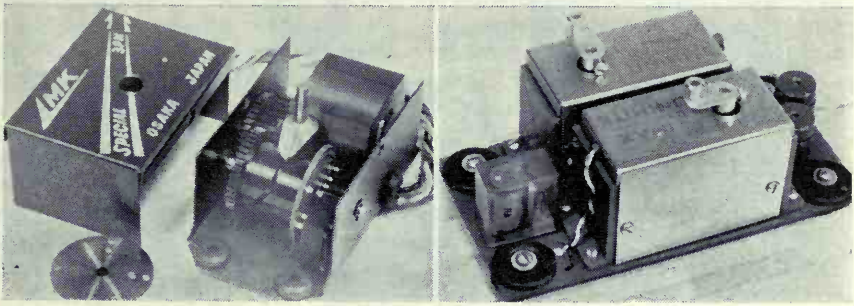
The alternative to a rubber driven

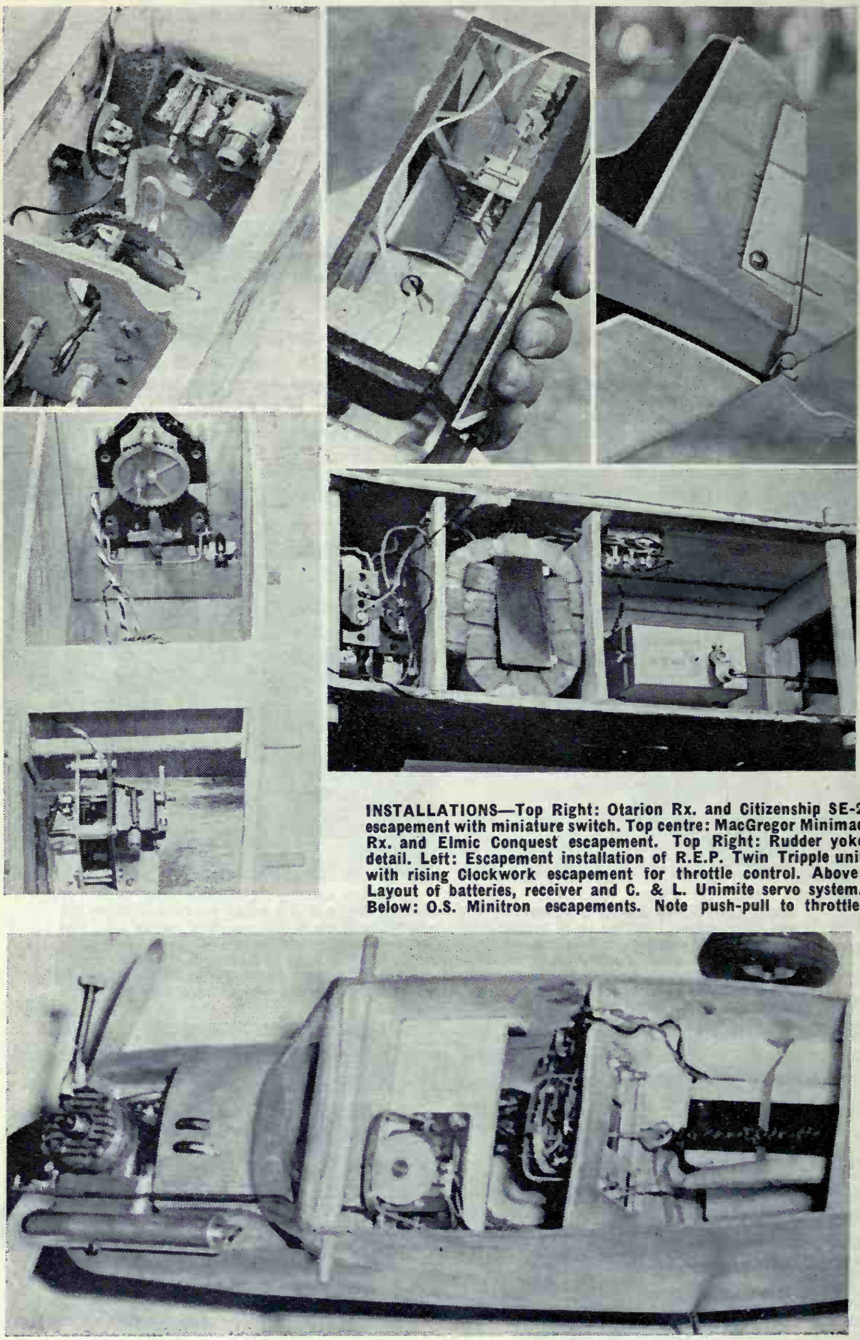


Left: British Elmic Conquest simple sequential escapement has been in production for six years but still preferred by many modellers to more modern "compound" types. Centre: Elmic "Compact" compound escapement provides selective left and right rudder with "kick-up" elevator movement and additional trigger to Elmic Corporal, sequential three position throttle control unit at right.

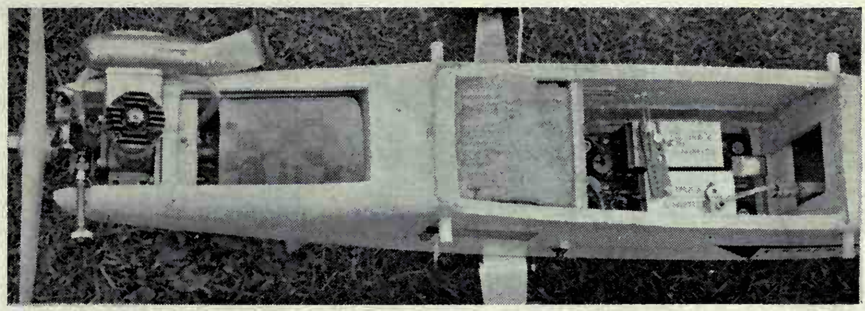


Above Left: Citizenship SE-2 escapement is a simple, lightweight unit which provides selective left and right rudder. Ideal for small models where installation space is at a premium. Above Left: The Bonner Vari-Comp compound escapement which has been popular for the last 10 years. Below Left: The fast M.K. single channel servo provides selective left and right rudder, with "third position" trigger to sequential unit. Below Right: The C. & L. Unimite pack comprises two Unimite servos wired to installation circuit board. Employs relay switcher, therefore may be used with any single channel receiver. Provides rudder and throttle functions.





INSTALLATIONS—Top Right: Otarion Rx. and Citizenship SE-2 escapement with miniature switch. Top centre: MacGregor Minimac Rx. and Elmic Conquest escapement. Top Right: Rudder yoke detail. Left: Escapement installation of R.E.P. Twin Tripple unit with rising Clockwork escapement for throttle control. Above: Layout of batteries, receiver and C. & L. Unimite servo system. Below: O.S. Minitron escapements. Note push-pull to throttle.



Power section and radio compartment. Enya 0·19 motor with O.S. silencer and Veco clunk tank. Note exhaust deflector. Radio compartment houses receiver packed in foam rubber and C. & L. Unimite servo pack.

escapement for single-channel operation is the motor driven servo, which is a comparatively recent innovation. In the single-channel servo the motive power is a battery driven electric motor which, as in the case of the escapement rotates a rotor arm through a series of pre-programmed positions on receipt of coded signals from the transmitter.

The simplest servo is the equivalent of the 2P2N escapement. It is sequential and gives rudder control only.

The more popular type is the Compound which gives rudder and motor control via a second servo, in exactly the same way as a rubber driven compound escapement. But whereas the escapement movement is controlled by the purely mechanical medium of a rotating pawl wheel, the servo movement is controlled by moving contacts over a printed circuit.

While it *is* possible to operate a servo direct from a relayless receiver, it is almost always advisable to put up with the extra weight of the two-battery system to avoid interference with the receiver from the servo motor. In the case of a relay receiver the problem does not arise as two batteries have to be employed anyway.

Advantages of the motor driven servo are greater power to operate the controls, and the elimination of the uncertainties of rubber drive, not the least of which is the possibility that the pilot will forget to wind it up.

The table on pp. 30–32 gives details of these servos at present available. The current demand of these units is such that you are well advised to use DEAC batteries for their operation and not dry cells. If you must use dry cells then the HP (high-power) Ever-Ready dry cells will give much better results and longer working life than the normal torch batteries. They are superior to the normal dry cell in both length of life, their ability to maintain a high proportion of their nominal voltage of 1·5V per cell during discharge, and their current capacity.

To sum up then, current single-channel equipment as exemplified in the tone-modulated all-transistor super-regenerative receiver and matching all-transistor transmitter has been developed to the stage where it is a reliable and effective piece of apparatus that only needs to be connected to a reliable power source to give adequate results with ample range. There is a wide choice of escapements and servos to complete the single-channel installation, which are also well proven and reliable. The beginner to radio control can, therefore, approach his first venture into this branch of the hobby with confidence that the equipment will cause him no difficulties.

RECEIVERS—SINGLE CHANNEL

Receiver	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*	*Transistors*
Emco Ace (British)	Emco of Coventry, 62 Lower Ford St., Coventry	—	Relayless tone	$2\frac{5}{8} \times 2\frac{1}{8} \times 1$	$1\frac{1}{2}$	4
Carrier Wave II (British)	MacGregor Industries, Station Wharf, Langley, Bucks.	—	Relayless Carrier Wave	$3\frac{1}{2} \times 2 \times 1\frac{1}{8}$ (caseless)	$1\frac{1}{4}$	3 + valve
C.S. 511 Honey Bee (U.S.A.)	C. & S. Distributors, 13400-12 Saticoy St., North Hollywood, California, U.S.A.	Roland Scott Ltd., 147 Derby St., Bolton, Lancs.	Relayless tone	$1\frac{5}{8} \times 1\frac{1}{8} \times \frac{5}{8}$ (caseless)	$\frac{5}{8}$	4
Controlaire 5 (U.S.A.)	World Engines Inc., 8206 Blue Ash Road, Cincinnati, Ohio, U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Relayless tone	$1\frac{9}{16} \times 1\frac{1}{8} \times \frac{9}{16}$ (caseless)	$\frac{3}{4}$	4
Gemini (British)	B.E.M.E. Telecommunications, R.E.P. Division, Chapel Lane, High Wycombe, Bucks.	—	Relayless tone	$1\frac{3}{4} \times 1\frac{1}{2} \times 1\frac{1}{4}$	$1\frac{1}{2}$	6
Kraft K3VK (U.S.A.)	Ace Radio Control, Box 301, Higginsville, Missouri, U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Relayless tone	$1\frac{11}{16} \times 1 \times \frac{3}{4}$ (caseless)	$\frac{3}{4}$	4
LT3 (U.S.A.)	Citizenship Radio Corp, 810 East 64th St., Indianapolis 20, Indiana, U.S.A.	Ripmax Model & Accessories Ltd., 86 Highgate Rd., London, NW5	Relayless tone	$2\frac{1}{8} \times 1\frac{1}{4} \times \frac{7}{8}$ (caseless)	1	4
MDL (U.S.A.)	Citizenship Radio Corp, 810 East 64th St., Indianapolis 20, Indiana, U.S.A.	Ripmax Model & Accessories Ltd., 86 Highgate Rd., London, NW5	Relayless tone	$1 \times \frac{7}{8} \times \frac{11}{16}$ (caseless)	$\frac{1}{2}$	4
Minimac (British)	MacGregor Industries, Station Wharf, Langley, Bucks.	—	Relayless tone	$2 \times 1\frac{3}{8} \times \frac{3}{4}$	1	5
Modelectric	Modelectric, 2 Hanover Gardens, London, EC11	—	Relayless tone	$1 \times 1 \times 2\frac{1}{4}$	1	5
Otarion O-21	Otarion Electronics, Post Rd., Ossining, New York, U.S.A.	—	Relayless tone	$1\frac{1}{4} \times 1 \times \frac{5}{8}$ (caseless)	$\frac{1}{2}$	4
Opal 400 (U.S.A.)	Spacetron Inc., Box 84, Broadview, Illinois, U.S.A.	—	Relayless tone	$1\frac{3}{4} \times 1\frac{1}{2} \times \frac{5}{8}$	2	4
Pioneer (U.S.A.)	F. & M. Electronics, 153 Vermont St., N.E., Albuquerque, N.M., U.S.A.	Southern Radio Controls, 1121B London Rd., Norbury, London, SW16	Relayless tone	$1\frac{3}{4} \times 1\frac{1}{4} \times \frac{3}{4}$ (caseless)	$\frac{3}{4}$	4
Silvertone (Australia)	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	Relayless tone	$2\frac{1}{8} \times 1\frac{1}{4} \times \frac{7}{8}$	$1\frac{1}{2}$	Valve + 4

RELAYLESS, SUPER-REGENERATIVE

Working voltage	*Batteries required. (Ever Ready quoted)*	*All-up weight (Rx. + batteries) (oz.)*	*Current drawn (mA)*		*Price*	*Important details for operation*
			Idle	*On signal*		
4·5V	3 × U7	3	0·65	300	£11.5.0	Price quoted is for transmitter and receiver
22·5V (HT) 1·5V (LT) 4·5V (output)	B122 (HT) U7 3 × U7	4¾	(HT) 1 (LT) 100 (Act) 0·05	1·2 100 300	£2.19.6	Receiver uses valve and is caseless. 4·5V separate actuator power supply
3V	2 × U7 or 3·6V 225 DKZ. DEAC	1⅝	6	325	£7.18.0	Caseless receiver light enough for smallest R/C models using only 0·15 c.c. (0·010 cu. in.) motors. Use Tx. with 600–900 c.p.s. tone for good results
3V	2 × U7 or 3·6V 225 DKZ. DEAC	1¾	3	200 to 400	$7.98 (kit) $13.98 (ass.)	Available either in kit or assembled. Responds best to Tx.'s with 80% or more modulation (500–1000 c.p.s.)
4·5V	3 × U7 or 4·8V DEAC	3	1·65	350	£15.15.0 with Tx.	Rx. and Tx. used matched tuned filters. Two filter frequencies are obtainable (3200 c.p.s. or 850 c.p.s.) permitting simultaneous operation of two models
3V	2 × U7 or 3·6V DEAC	1¾	2	150	£4.19.6 (kit) £5.19.6 (ass.)	Requires 400–600 c.p.s. tone signal of near 100% modulation for best results. Many do not work satisfactorily at temperatures below 40 degrees F.
3V	2 × U7 or 3·6V DEAC	2	3	300	$22.95 (U.S.A.)	Will probably work best with Tx. with 80-100% modulation level
3V	2 × U7 or 3·6V DEAC	1½	8	300	$24.95 (U.S.A.)	Use Tx. with 80–100 modulation level
3–4·5V	2 or 3 × U7	2–2½	1·6	300	£8.19.6	May also be used with separate actuator power supply in which case Rx. uses 3V and actuator 3–4·5V, bring all up weight to 3–3½ oz.
9V (Rx.) 3V (Act.)	PP3 (Rx.) 2 × U7 (Act.)	3	(Rx.) 3·5 (Act.) 0·1	3·5 400	£8.7.6	Responds to any tone 400–4000 c.p.s., 700 c.p.s. optimum
3V	2 × U7 or 3·6V DEAC	1½	4	360	£11.13.9	Pea bulb illuminated on receipt of signal, indicates Rx. on tune
3V	2 × U7 or 3·6V DEAC	3	1	300	$18.95 (U.S.A.)	Completely encapsulated in foam epoxy for maximum crash protection. May be immersed in water without circuit damage
3V	2 × U7 or 3·6V DEAC	1¾	4·8	250	£8.10.6	Use escapement with fairly high coil resistance for best results—say 9 ohms
22·5V (HT) 1·5V (LT) 3–4·5V (Act.)	B122 (HT) U7 (LT) 2 or 3 × U7 (Act.)	4½	(HT) 0·95 (LT) 2·5 (Act.) —	6 2·5 450	£A12.19.6	Uses valve detector stage, followed by transistorised audio amplifying stages and output switcher

RECEIVERS—SINGLE CHANNEL

Receiver	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*	*Transistors*
Terrytone II (Kit) (British)	MacGregor Industries	—	Relayless tone	3 × 2 × ½ (caseless)	1¼	4

RECEIVERS—SINGLE CHANNEL SUPER-

These operate standard escapements, and for motor control. Also operate

CS505A **Finch II** **(U.S.A.)**	C. & S. Distributors, 13400-12 Saticoy St., North Hollywood, U.S.A.	Roland Scott Ltd., 147 Derby St., Bolton, Lancs.	Relayless tone	1⅝ × 1¼ × ¾ (caseless)	¾	5
Guidance System II (British)	Radio Control Specialists Ltd., National Works, Bath Rd., Hounslow, Middx.	—	Relayless tone	1⅞ × $1\frac{5}{16}$ × 1	1	5
Otarion O-22 (U.S.A.)	Otarion Electronics, Post Rd., Ossining, New York, U.S.A.	—	Relayless tone	1½ × 1 × ⅝ (caseless)	⅝	5
Sportsmaster (U.S.A.)	Min-X Radio, 8714 Grand River Ave., Detroit 4, Mich., U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Relayless tone	$1\frac{15}{16}$ × 1⅜ × ⅝ (caseless)	1	5

RECEIVERS—SINGLE CHANNEL

Capri (U.S.A.	Min-X Radio, 8714 Grand River Ave., Detroit 4, Mich., U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Relay tone	$1\frac{15}{16}$ × $1\frac{5}{16}$ × $\frac{15}{16}$	2	4
Controlaire 4 (U.S.A.)	World Engines Inc., 8206 Blue Ash Road, Cincinnati, Ohio, U.S.A.	Ed. Johnson Radio Control, Larkhill, Wilts.	Relay tone	2 × $1\frac{7}{16}$ × ⅞	1¾	4
CS503A **Lark II** (U.S.A.)	C. & S. Distributors, 13400-12 Saticoy St., North Hollywood, California, U.S.A.	Roland Scott Ltd., 147 Derby St., Bolton, Lancs.	Relay tone	2⅛ × 1½ × 1	1⅝	4
Gemini (British)	B.E.M.E. Telecommunications, R.E.P. Division, Chapel Lane, High Wycombe, Bucks.	—	Relay tone	1¾ × 1½ × 1¼	1½	6
Hill MkII (British)	Harrogate Radio, 16 Regent Parade, Harrogate	—	Relay carrier	3⅛ × 1¾ × 1¾	3	—
Pixie (Japan)	Ogawa Model Mfg. Co., Hiranobaba, Higashisumiyoshi, Osaka, Japan	E. Keil & Co. Ltd., Wickford, Essex	Relay tone	2⅛ × 1¼ × 1⅛	1½	4
Saturn (U.S.A.)	F. & M. Electronics, 153 Vermont St., N.E., Albuguerque, N.M. U.S.A.	Southern Radio Controls, 1121B London Road, Norbury, London, SW16	Relay tone	2 × $1\frac{5}{16}$ × ⅞	1¾	4
Silvertone (Australia)	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	Relay tone	2¼ × 1¾ × 1	2	Valve + 3

RELAYLESS, SUPER-REGENERATIVE (cont.)

Working voltage	*Batteries required. (Ever Ready quoted)*	*All-up weight (Rx. + batteries) (oz.)*	*Current drawn (mA)*		*Price*	*Important details for operation*
			Idle	*On signal*		
4·5V	3 × U7 or 4·8V DEAC	2¾	1	250	£5.19.6 (kit)	May also be used with separate 3–4·5V actuator battery. All up weight in this case 3¾–4¾ oz.

REGENERATIVE, RELAYLESS (DUAL OUTPUT)

in addition provide "Quick Blip" trigger magnetic proportional actuators

3V	2 × U7 or 3·6V DEAC	1¾–2	Unknown		£9.18.0	Use escapements with coil resistance of not less than 8 ohms for best operation
4·5V	3 × U7 or 4·8V DEAC	2½	1·8	380	£7.0.0	Use of DEAC battery preferable when "Quick Blip" throttle escapement in circuit
3V	2 × U7 or 3·6V DEAC	1⅝	Unknown		$29.95 U.S.A.	Use of DEAC battery preferable when "Quick Blip" throttle escapement in circuit
3V	2 × U7 or 3·6V DEAC	2	6	300	£7.10.0	Use of DEAC battery preferable

SUPER-REGENERATIVE, RELAY

3V	2 × U7 or 3·6V DEAC	3	7·5	28	£12.10.0	Use transmitter with 90–100% modulation level. Tone range 200–1000 c.p.s.—800 c.p.s. optimum
3V	2 × U7 or 3·6V DEAC	2¾	3	50	$19.98 (ass.) $14.98 (kit) (U.S.A.)	Optimum tone frequency 600 c.p.s. 300–100 c.p.s. operation tolerance
3V	2 × U7 or 3·6V DEAC	2⅝	6	48	$29.50 (U.S.A.)	Deans Relay. 600 c.p.s. optimum tone
4·5V	3 × U7 or 4·8V DEAC	3	1·7	50	£16.16.0 with transmitter	Transmitter and receiver incorporate matched tuned filters. Two tone frequencies (3200 and 850 c.p.s.) may be obtained permitting simultaneous operation
30V (HT) 1·5V (LT)	B105 (HT) D18 (LT)	9	(HT) 0·4 (LT) 100	4 100	(kit)	Circuit employs two valves—no transistors
9V	PP3	2½	3·5	22	£16.5.0 complete with transmitter	Printed circuit taggboard protrudes from case for Rx. battery and actuator connections
3V	2 × U7 or 3·6V DEAC	2¼	4	82	£13.19.6	Requires Tx. signal of 80% modulation or more. 300–700 c.p.s. tone frequency range—500 c.p.s. optimum
22·5V (HT) 1·5V (LT)	B122 (HT) U7 (LT)	3½	(HT) 1 (LT) 25	6	£A13.16.0	Uses sub-miniature valve detector stage followed by three transistor amplifying stages to relay

RECEIVERS—SINGLE CHANNEL

Receiver	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*	*Tran-sistors*
U.K.	Harrogate Radio Co., 16 Regent Parade, Harrogate	—	Relay tone	$2\frac{1}{4} \times 1\frac{3}{4} \times 1\frac{1}{8}$	$2\frac{1}{2}$	Valve + 2

RECEIVERS—SINGLE

Due to the necessity to carefully match superhet receiver be purchased together unless purchaser has the

C.S. 507S Oriole (U.S.A.)	C. & S. Electronics, 7377 Beverly Boulevard, Los Angeles36, California, U.S.A.	Roland Scott Ltd., 147 Derby St., Bolton, Lancs.	Relay tone	$2\frac{1}{2} \times 1\frac{3}{4} \times 1$	$2\frac{1}{2}$	6
C.S. 508S Cardinal (U.S.A.)	C. & S. Electronics, 7377 Beverly Boulevard, Los Angeles 36, California, U.S.A.	Roland Scott Ltd., 147 Derby St., Bolton, Lancs.	Relay tone	$3 \times 1\frac{3}{4} \times 1$	3	6
Kraft SH1 (U.S.A.)	Kraft Custom Radio Control, 2519 Lee Avenue, South El Monte, California, U.S.A.	Henry J. Nicholls Ltd., 308 Holloway Road, London, N7	Relay tone	$1 \times 1\frac{7}{8} \times 2\frac{3}{8}$	$2\frac{1}{2}$	6
R.C.S. 1 (British)	Radio Control Specialists, National Works, Bath Road, Hounslow, Middx.	—	Relayless tone	$3 \times 1\frac{3}{4} \times 1\frac{5}{16}$	3	6
R.S.H. (U.S.A.)	Citizenship Radio Corp., 810 East 64th St., Indianapolis, Indiana	Ripmax Model & Accessories Ltd., 86 Highgate Road, London, NW5	Relayless tone	$2 \times 1\frac{1}{2} \times \frac{3}{4}$ (caseless)	$1\frac{1}{4}$	7
SH-100 (U.S.A.)	World Engines Inc., Blue Ash Road, Cincinnati, Ohio, U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Relay tone	$2\frac{1}{16} \times 1\frac{7}{16} \times \frac{15}{16}$	$2\frac{1}{2}$	6
Superhet 1200 (U.S.A.)	Min-X Radio Inc., 8714 Grand River Ave., Detroit, Mich., U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Relay tone	$2\frac{7}{8} \times 1\frac{7}{8} \times 1$	$3\frac{1}{2}$	8
Vanguard U.S.A.)	F. & M. Electronics, 153 Vermont St., N.E., Albuquerque, N.M., U.S.A.	Southern Radio Controls, 1121B London Road, Norbury, London, SW16	Relay tone	$2\frac{3}{8} \times 1\frac{5}{8} \times 1$	$2\frac{1}{4}$	7

TRANSMITTERS—

Transmitter	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*	*Voltage*
Astral (British)	Modelectric, 2 Hanover Gardens, London, EC11	—	Tone transistor	$5\frac{3}{4} \times 3\frac{7}{8} \times 2\frac{1}{4}$		18V
Carrier Wave MkII (British)	MacGregor Industries, Station Wharf, Langley, Bucks.	—	Carrier wave (valve)	$4 \times 3 \times 2\frac{1}{2}$ (baseboard only)	3	HT 90–120V LT 1.5V

SUPER-REGENERATIVE, RELAY (cont.)

Working voltage	*Batteries required. (Ever Ready quoted)*	*All-up weight (Rx. + batteries) (oz.)*	*Current drawn (mA)*		*Price*	*Important details for operation*
			Idle	*On signal*		
22·5V (HT) 1·5V (LT)	B122 (HT) U7 (LT)	4	(HT) 1 (LT) 30	6 30	Components sold separately	Uses sub-miniature XFY34 valve detector stage followed by two transistor amplifying stages to relay

CHANNEL SUPERHET

to transmitter it is recommended that superhet Rx. and Tx. necessary electronic equipment to match up the two

6V	4 × U7 or 6·25V DEAC	4½	13		$59.50 (U.S.A.)	Employs transfilters in I.F. stages DEAC power supply preferable. Convertible to multi
6V	4 × U7 or 6·25V DEAC	5	13		$59.58 (U.S.A.)	Same as C.S. 507 but slightly longer to accommodate Medco reed block in event of multi conversion. C.S. 507 multi uses smaller New Haven reed block
9V	PP3	3½			£32.0.0 complete with Tx.	
7·2V	5 × U7 or 7·2 DEAC	6	5·1	350	£24.0.0	Relayless output permits triggering of secondary escapement of throttle control
3–4·5V	2 or 3 × U7 or 3·6V DEAC	2¼–2¾	5		$34.95 (U.S.A.)	Works satisfactorily on 3V with Citizenship PSN-2 or SE2 escapements (can be supplied as extra) but may require 4·5V or 3·6V DEAC for other escapements which should have 8–10 ohm coil resistance
3V	2 × U7 or 3·6V DEAC	3½	6	48	$24.98 (kit) $32.98 (ass.) (U.S.A.)	Requires Tx. modulation of 95–100%. Operates with 400–100 c.p.s. tone—700 c.p.s. optimum. Very insensitive to noise interference
3V	2 × U7 or 3·6V DEAC	4½	6	35	£25.0.0	Rx. incorporates 1200 c.p.s. tuned filter and responds only to signal of that frequency such as Min-X Powermite 1200. Use of DEAC power pack recommended
3V (3·2V max.)	2 × U7	2¾	10	58	£18.10.6	Tone frequency range 300–1000 c.p.s. 500 c.p.s. optimum

SINGLE CHANNEL

Batteries required (Ever Ready)	*Aerial*	*Current drain (mA)*		*Modulation %*	*Tone frequency c.p.s.*	*Price*	*Other details*
		Idle	*Signal*				
2 × PP7	53 in.	26.5	18.5	100	800	£11.9.9	Continuous carrier wave when switched on. Crystal controlled
B135 AD4	48 in.	HT — LT 200	15 200	—	—	£2.19.6	Supplied without case or aerial. Weight quoted in this state

TRANSMITTERS—

Transmitter	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*	*Voltage*
Citizenship SPX (U.S.A.)	Citizenship Radio Corp., 810 East 64th St., Indianapolis, Indiana, U.S.A.	Ripmax Ltd., 86 Highgate Rd., London, NW5	Tone transistor	$6\frac{1}{4} \times 3\frac{5}{8} \times 2\frac{3}{4}$	30	9V
Citizenship TTX (U.S.A.)	Citizenship Radio Corp., 810 East 64th St., Indianapolis, Indiana, U.S.A.	Ripmax Ltd., 86 Highgate Rd., London, NW5	Tone transistor	$5\frac{1}{2} \times 3\frac{1}{4} \times 1\frac{5}{8}$	12	9V
Converter Modulator (British)	MacGregor Industries, Station Wharf, Langley, Bucks.	—	Tone valve/ transistor	$7\frac{1}{2} \times 6 \times 1\frac{7}{8}$	36	HT 9V LT 1.5V
Cougar I (U.S.A.)	Spacetron Inc., Box 84, Broadview, Illinios, U.S.A.	—	Tone transistor	$5 \times 4\frac{3}{16} \times 1\frac{7}{8}$		9V
C.S. 509 Falcon II (U.S.A.)	C. & S. Distributors, 13400-12 Saticoy St., North Hollywood, California U.S.A.	Roland Scott Ltd., 147 Derby St., Bolton, Lancs.	Tone transistor	$6 \times 4 \times 2$		9V
Echo (U.S.A.)	F. & M. Electronics, 153 Vermont St., N.E., Albuquerque, N.M., U.S.A.	Southern Radio Controls, 1121B London Rd., Norbury, London, SE16	Tone transistor	$7 \times 4\frac{1}{2} \times 2\frac{3}{4}$	39	6V
Emco Ace (British)	Emco of Coventry, 62 Lower Ford St., Coventry	—	Tone valve	$7\frac{3}{4} \times 6 \times 2\frac{1}{8}$	63	HT 135V LT 1.5V
Gemini (British)	Derriton Radio Ltd., (R.E.P. Division), Chapel Rd., High Wycombe, Bucks.	—	Tone transistor	$6\frac{3}{8} \times 3\frac{1}{2} \times 2\frac{1}{8}$	24	9V
Guidance System II (British)	Radio Control Specialists, National Works, Bath Rd., Hounslow, Middx.	—	Tone transistor	$5\frac{1}{2} \times 3\frac{1}{2} \times 2\frac{3}{8}$		12V
Kraft Commander	Ace Radio Control, Box 301, Higginsville, Missouri, U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Tone transistor	$5 \times 3\frac{1}{2} \times 2$		9V
Kraft KT1 (U.S.A.)	Kraft Custom Radio Control, 2519 Lee Avenue, South El Monte, California, U.S.A.	Henry J. Nicholls Ltd., 308 Holloway Rd., London, N7	Tone transistor	$6 \times 4\frac{3}{8} \times 2\frac{1}{2}$		9V
Mule II (U.S.A.) (kit)	World Engines Inc., 8206 Blue Ash Rd., Cincinnati, Ohio, U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Tone transistor	$6 \times 4 \times 2$	28	9V
Otarion O-31 (U.S.A.)	Otarion Electronics, Post Rd., Ossining, New York, U.S.A.	—	Tone transistor	$6 \times 3\frac{7}{8} \times 2$	26	18V
Pixie (Japan)	Ogawa Model Mfg. Co., Hiranababa, Higashisumiyoshi, Osaka, Japan	E. Keil & Co. Ltd., Wickford, Essex	Tone transistor	$3\frac{5}{8} \times 2\frac{1}{4} \times 1\frac{1}{4}$	6	9V
Powermite TT1 (U.S.A.)	Min-X Radio Inc., 8714 Grand River Ave., Detroit, Michigan, U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Tone transistor	$6\frac{1}{8} \times 4\frac{1}{2} \times 2\frac{1}{2}$	28	9V

SINGLE CHANNEL (cont.)

Batteries required (Ever Ready)	*Aerial*	*Current drain (mA)*		*Modulation %*	*Tone frequency c.p.s.*	*Price*	*Other details*
		Idle	*Signal*				
PP9	Off centre loaded		60	100		$39.95 (U.S.A.)	Extra switch controls continuous carrier or keyed carrier/tone modes. Crystal controlled
	36 in. off centre loaded			100		$29.95 (U.S.A.)	Same as above
2 × 1289 AD35	39½ in.	HT LT 100	290 100	90	450	£8.19.6	Power converter supplying HT voltage to circuit is used to modulate carrier wave. Tone and carrier keyed simultaneously
PP9		30		90–100	700	$34.95 (U.S.A.)	Crystal controlled
PP9	55 in. centre loaded			85	800	$34.50 (U.S.A.)	Crystal controlled
Lantern battery	54 in.	180	200	95	580	£12.19.6	Continuous carrier wave. Crystal controlled
2 × B101 AD35	28½ in.	HT LT 200	14 200		1,100	£11.5.0 Complete with receiver	No continuous carrier wave. Carrier and tone keyed simultaneously
PP9	48 in. centre loaded	21	16	100	850 or 3,200	£18.14.3 (relayless) £19.7.3 (relay) Tx. and Rx.	Tone frequency set to operate Gemini tuned filter selective receiver. Pre-assembly kit also available price £13.17.8–£14.5.0.
2 × PP1	44 in. centre loaded	44	34	100	500	£7.0.0	Crystal controlled. Continuous carrier wave
PP9	54 in.			100	500	$17.95 (U.S.A.)	Crystal controlled. Continuous carrier wave. Has micro-switch keying button
PP9	56 in.			100	500	$29.95 (U.S.A.) Sold complete with superhet Rx. for £31.0.0	Continuous carrier wave. Crystal controlled
PP9	48 in. centre loaded	45	45	97	700	$29.98 (U.S.A.) (kit)	Continuous carrier wave. Crystal controlled
2 × PP9	42 in.	36	52	100	600	$39.95 (U.S.A.)	May be used with either continuous carrier or keyed carrier/tone modes. Crystal controlled
PP3	36 in. centre loaded	48	50	100	800	£16.5.0 Complete with receiver	Smallest transmitter in current production. Continuous carrier wave. Crystal controlled
PP9	24 in. centre loaded	48	50	100	800	£15.0.0	Continuous carrier wave. Crystal controlled. Aerial does not short out centre loading coil when collapsed

TRANSMITTERS—

Transmitter	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*	*Voltage*
Powermite 1200K (U.S.A.)	Min-X Radio Inc., 8714 Grand River Ave., Detroit, Michigan, U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Tone transistor	$6\frac{1}{8} \times 4\frac{1}{2} \times 2\frac{1}{2}$	28	9V
Pulsemite 1200 and 800 (U.S.A.)	Min-X Radio Inc., 8704 Grand River Ave., Detroit, Michigan, U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Tone transistor pulse proportional	$6\frac{1}{2} \times 5 \times 2\frac{1}{2}$	32	9V
Transistor Transmitter (British)	MacGregor Industries, Station Wharf, Langley, Bucks.	—	Tone transistor	$7 \times 6\frac{1}{2} \times 1\frac{3}{4}$	30	18V

ESCAPE

Escapement	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Functions*
Babcock MkII Super-compound (U.S.A.)	Babcock Controls Inc., 20762 Laguna Canyon Rd., P.O. Box 666, Laguna Beach, California, U.S.A.	Henry J. Nicholls Ltd., 308 Holloway Rd., London, N7	Compound selective	Left and right rudder, up elevator, plus "quick-blip" to throttle escapement
Babcock MkV Hyper-compound (U.S.A.)	Babcock Controls Inc., 20762 Laguna Canyon Rd., P.O. Box 666, Laguna Beach, California, U.S.A.	Henry J. Nicholls Ltd., 308 Holloway Rd., London, N7	Compound selective	Right and left rudder, up and down elevator, plus "quick-blip" trigger to throttle escapement
Babcock EM1 (U.S.A.)	Babcock Controls Inc., 20762 Laguna Canyon Rd., P.O. Box 666, Laguna Beach, California, U.S.A.	Henry J. Nicholls Ltd., 308 Holloway Rd., London, N7	Sequential	Two position throttle control
Bonner SN (U.S.A.)	Bonner Specialities Inc., 9522 W. Jefferson Blvd., Culver City, California, U.S.A.	Henry J. Nicholls Ltd., 308 Holloway Rd., London, N7	Sequential self neutralising	Left-neutral-right-neutral sequence for rudder or fast–slow throttle control
Conquest (British)	Scorpion Precission Products Ltd., Elmic Works, Gallows Corner, Southend Arterial Rd., Romford, Essex	—	Sequential self neutralising	Left and right rudder or fast and slow throttle according to application
Commander (British)	As Conquest	—	Compound selective	Left and right for rudder; "quick-blip" to Corpral throttle escapement
Corporal	As Conquest	—	Sequential	Two position action for throttle control
Compact	As Conquest	—	Compound selective	Left and right rudder, up elevator, plus "quick-blip" trigger to throttle escapement (Corpral)
O.S. Minitron K1 (Japan)	Ogawa Model Mfg. Co., Hiranababa, Higashisumiyoshi, Osaka, Japan	E. Keil & Co. Ltd., Wickford, Essex	Compound selective	Left and right rudder, plus third position trigger for throttle escapement
O.S. Minitron S2 (Japan)	Ogawa Model Mfg. Co., Hiranababa, Higashisumiyoshi, Osaka, Japan	E. Keil & Co. Ltd., Wickford, Essex	Sequential	Two positions for fast and slow speed throttle control

SINGLE CHANNEL (cont.)

Batteries required (Ever Ready)	*Aerial*	*Current drain (mA)*		*Modulation %*	*Tone frequency c.p.s.*	*Price*	*Other details*
		Idle	*Signal*				
PP9	24 in. centre loaded	48	50	90–95	1,200	£15.0.0	Use Powermite T.T.1. 1200 c.p.s. tone to suit Min-X Superhet 1200, tuned filter superhet receiver
PP9	24 in. centre loaded	56	48	90–95	1,200 or 800	£30.0.0	Pulse proportional Tx. for Galloping Ghost system. 70/30 mark/space variation, 1:35 to 16 p.p.s. pulse rate variation. 1200 c.p.s. unit for Superhet 1200 selective receiver. 800 c.p.s. unit for Min-X Capri receiver. Crystal controlled. No relays
4 × 1289	48 in.	36	55	90	590	£10.19.6	Continuous carrier wave. Crystal controlled

MENTS

Size (inches)	*Wt. (oz.)*	*Voltage*	*Coil resistance (ohms)*	*Price*	*Other details*
1⅜ × 2½ × 1	¾	3–4.5V	7		Right is first position, left second and "up" third position just before neutral
1⅜ × 2½ × 1	¾	3–4.5V	7		Right is first position, up second, left third and down fourth
1¾ × 1 ×		3–4.5V	7	£3.19.6	Triggered from "quick-blip" impulse from compound escapement or from one separate channel of multi channel unit
1½ × 1¼ × 1	⅝	3–4.5V	8	£4.9.6	For throttle control application is triggered by "quick-blip" impulse from compound escapement or one separate channel of multi channel unit
1⅝ × ⅞ × 1	⅝	3–4.5V	11.5	£1.15.0	
1⅞ × 1½ × ⅞	⅞	3–4.5V	11.5	£2.19.2	Mechanical "quick-blip" contact on unit permits use of relayless single ended output receivers. Eliminates necessity for relay back-contact circuit
2⅛ × 1½ × ⅞	¾	3–4.5V	11.5	£2.7.4	Push-pull output drive
1⅜ × 1⅜ × 1	0.8	3–4.5V	8	£3.7.4	Mechanical "quick-blip" control as per Commander. Series resistor increases resistance to 16 ohms
1¾ × 1⅜ × 1		3–6V	10		Push-pull drive arm
1¾ × 1 × 1⅜		3–6V	10		Push-pull drive arm

ESCAPE

Escapement	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Functions*
O.S. Minitron S4 (Japan)	Ogawa Model Mfg. Co., Hiranababa, Higashisumiyoshi, Osaka, Japan	E. Keil & Co. Ltd., Wickford, Essex	Sequential. Four positions in progression	Four positions providing fast, intermediate, slow, intermediate etc., throttle functions in progression
Rising 2 Pawl Clockwork (British)	Rising & Schultz, Central Garage, Whissendine, Nr. Oakham, Rutland	—	Sequential. Two position self neutralising	Left and right rudder in sequence or fast and slow throttle according to application
Rising 4 Pawl Clockwork (British)	Rising & Schultz, Central Garage, Whissendine, Nr. Oakham, Rutland	—	Sequential	Holds four positions in sequential progression for fast, intermediate, slow, intermediate etc., throttle functions
Rising Lightweight S/N (British)	Rising & Schultz, Central Garage, Whissendine, Nr. Oakham Rutland	—	Two position sequential self neutralising	Right-neutral-left-neutral sequence or fast and slow throttle positions according to application
Rising Compound (British)	Rising & Schultz, Central Garage, Whissendine, Nr. Oakham, Rutland	—	Compound selective	Left and right rudder plus "quick-blip" trigger to throttle escapement using relay back-contact, or relayless double-ended output Rx.
PSN-2 (U.S.A.)	Citizenship Radio Corp., 810 East 64th St., Indianapolis, Indiana, U.S.A.	Ripmax Ltd., 86 Highgate Rd., London, N7	Sequential self neutralising	Left and right rudder or fast and slow throttle according to application
SE-2 (U.S.A.)	Citizenship Radio Corp., 810 East 64th St., Indianapolis, Indiana, U.S.A.	Ripmax Ltd., 86 Highgate Rd., London, NW5	Selective	Left and right rudder
SE-2M (U.S.A.)	Citizenship Radio Corp., 810 East 64th St., Indianapolis, Indiana, U.S.A.	Ripmax Ltd., 86 Highgate Rd., London, NW5	Compound selective	Left and right rudder plus "quick-blip" trigger to throttle escapement (PSN-2)
Varicomp (U.S.A.)	Bonner Specialities Inc., 9522 W. Jefferson Blvd., Culver City, California, U.S.A.	Henry J. Nicholls Ltd., 308 Holloway Rd., London, N7	Compound selective	Left and right rudder, plus "quick-blip" trigger to throttle escapement
Varicomp RE (U.S.A.)	Bonner Specialities Inc., 9522 W. Jefferson Blvd., Culver City, California, U.S.A.	Henry J. Nicholls Ltd., 308 Holloway Rd., London, N7	Compound selective	Left and right rudder, up elevator, plus "quick blip" trigger to throttle escapement

SERVOS—

Servo	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Functions*
Atlas PCS-100 (U.S.A.)	Don Steeb Inc., 955 Milsteed Way, Rochester, New York, U.S.A.	—	Selective. Relay operated	Left and right rudder, self neutralising
Metz 190/18 (West Germany)	Metz Apparatewerke, Furth/Bayern, West Germany	F. A. & F. Allen Ltd., 2 Dickens Lane, Poynton, Cheshire	Selective. Relay operated	Left and right rudder, self neutralising

MENTS (cont.)

Size (inches)	*Wt. (oz.)*	*Voltage*	*Coil resistance (ohms)*	*Price*	*Other details*
$1\frac{3}{4} \times 1 \times 1\frac{3}{8}$		3–6V	10		Push-pull drive arm
$1\frac{3}{8} \times 1\frac{1}{2} \times \frac{3}{4}$	$1\frac{1}{4}$	4.5–6V	7	£2.1.4	Clockwork motor eliminates rubber band power, permitting compact installation
$1\frac{3}{8} \times 1\frac{1}{2} \times \frac{3}{4}$	$1\frac{1}{4}$	4.5–6V	7	£2.4.3	As above
$1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{4}$	$\frac{1}{2}$	4.5–6V	7	£1.5.3	
$2\frac{1}{4} \times 1\frac{1}{4} \times \frac{3}{4}$	1	4.5–6V	7	£2.9.11	
$\frac{7}{8} \times \frac{7}{8} \times \frac{5}{8}$	$\frac{3}{4}$	3–4.5V	9	$5.95 (U.S.A.)	
$1\frac{3}{8} \times 1\frac{3}{8} \times \frac{5}{8}$	$\frac{7}{8}$	3–4.5V	9	$7.95 (U.S.A.)	No third position or "quick-blip" provision
	$1\frac{1}{4}$	3–4.5V	9	$12.95 (U.S.A.)	Transistorised "quick-blip" switcher for operation with single ended output relayless receivers. May also be used with relay receivers
$2\frac{1}{8} \times 1\frac{1}{4} \times 1\frac{1}{4}$	$1\frac{1}{8}$	3–4.5V	8		
$2\frac{1}{8} \times 1\frac{1}{4} \times 1\frac{1}{4}$	$1\frac{1}{4}$	3–4.5V	8		

SINGLE CHANNEL

Size (inches)	*Wt. (oz.)*	*Voltage*	*Current drain (mA)*	*Price*	*Other details*
$2\frac{1}{2} \times 1\frac{7}{16} \times 1\frac{1}{16}$	2			$12.95 (U.S.A.)	
$2\frac{1}{4} \times 1\frac{1}{4} \times 1\frac{1}{8}$	$2\frac{1}{8}$	6V	400		

SERVOS—

Servo	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Functions*
Minicombo (West Germany)	Alexander Engel	E. Keil & Co. Ltd., Wickford, Essex	Sequential. Relay operated	Left-neutral-right-neutral in progression
Minicombo II (West Germany)	Alexander Engel	E. Keil & Co. Ltd., Wickford, Essex	Selective. Relay operated	Left and right rudder in selective sequence, self neutralising
M.K. Type 7 (Japan)	Kato Model Aircraft Co., 7, 4-chome, Hattori-Honmacki, Toyonaka, Osaka, Japan	Henry J. Nicholls Ltd., 308 Holloway Rd., London, N7	Selective. Relay operated	Left and right rudder in selective sequence. Self neutralising, plus third position trigger to secondary Type 7A throttle control
M.K. Type 7A (Japan)	Kato Model Aircraft Co., 7, 4-chome, Hattori-Honmachi, Toyonaka, Osaka, Japan	Henry J. Nicholls Ltd., 208 Holloway Rd., London, N7	Three position sequential	Three progressive positions to provide fast, intermediate and slow throttle control
R1 (Germany)	Robbe, 6421 Metzlos-Geheiag, W. Germany	Skol-Kits Ltd., 166 Mile End Rd., London, E1	Sequential. Relay operated	Left-neutral-right-neutral in progression
Slim Jim (British)	Modelectric, 2 Hanover Gardens, London, SE11	—	Selective. Relay operated	Left and right rudder in selective sequence, plus third position trigger to secondary unit for throttle control
Slim Jim Relayless (British)	Modelectric, 2 Hanover Gardens, London, SE11	—	Selective. Relayless operation and sequential	Left and right rudder in selective sequence, plus third position trigger to secondary unit for throttle control
Unimatic (Germany)	Johannes Graupner, Kirchhiem/Teck, West Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	Selective, sequential or cascaded unit (see "other details" column)	1. Selective left and right rudder with third position impulse to cascaded throttle unit. 2. Sequential left-neutral-right-neutral. 3. Cascaded unit from selective Unimatic
Unimite (British)	C. & L. Developments Ltd., 47 Queens Rd., Weybridge, Surrey	—	Selective or cascaded unit	Selective left and right rudder with "quick-blip" trigger to second Unimite for three position throttle
Unipack (British)	C. & L. Developments Ltd., 47 Queens Rd., Weybridge, Surrey	—	Twin servo installation pack (see "other details")	Selective left and right rudder, plus three position throttle triggered by "quick-blip" impulse

R/C FREQUENCIES

Country	*Frequencies (Mc/s.)*								*No. of FAI Licensed R/C Flyers*
1 U.S.A.		26·995, 27·045, 27·095 27·145, 27·195, 27·255						465	Over 5,000
2 England		26·96–27·28						459 ± ½	Over 6,400
3 Germany	13·6	27		40					Over 1,000
4 Switzerland	13·56	26·965–27·195		40·68			433·2 434·6		Over 100
5 France		27·120			72	144			Under 100
6 Belgium		26·96–27·24	32·0–32·5		72·0–72·5				Under 100
7 Sweden		27							
8 Holland		27·095, 27·105, 27·115, 27·125, 27·135, 27·145 ±.005%					144–146		Under 100

SINGLE CHANNEL (cont.)

Size (inches)	*Wt. (oz.)*	*Voltage*	*Current drain (mA)*	*Price*	*Other details*
$2\times1\frac{1}{2}\times1\frac{3}{8}$	$1\frac{1}{4}$	1.5V+ 1.5V or 3V+3V	400 or 600	£2.0.11	One battery used to drive, other is "sniff back" brake for accurate neutralising
$2\times1\frac{1}{2}\times1\frac{3}{8}$	$1\frac{1}{4}$	1.5V+ 1.5V or 3V+3V	400 or 600	£2.4.10	As above
$2\times1\frac{1}{2}\times1\frac{3}{8}$	1.9	1.5V+ 1.5V	120	£4.7.6	3V battery centre tapped. One half used for drive, other for accurate "sniff-back" positioning and neutralising
$2\frac{5}{8}\times1\frac{3}{8}\times1$	$1\frac{3}{4}$	1.5V	120	£4.3.6	May also be triggered by "quick-blip" impulse from a compound escapement
$2\frac{1}{8}\times1\frac{3}{8}\times1$	1.85	4.5V–6V	125	£4.17.1	
$2\frac{1}{8}\times2\frac{1}{8}\times\frac{7}{8}$	1	4.5V	140	£3.10.0	
$2\frac{1}{8}\times2\frac{1}{8}\times\frac{7}{8}$	1.2	4.5V	140–400	Selective £4.15.0 Sequential £3.8.0	Transistorised circuit on servo permits operation with simple relayless receivers normally unable to switch motorised single channel actuators
$2\frac{7}{8}\times\frac{7}{8}\times1\frac{1}{4}$	2	2.4–3V		£3.19.6	Unimatic supplied with three switching discs permitting operation modes as detailed under "Functions"
$2\frac{11}{16}\times1\frac{7}{16}\times1\frac{1}{16}$	$1\frac{1}{2}$	4.5V	400	£3.10.0	High speed action
$4\frac{1}{2}\times2\frac{3}{8}\times1\frac{5}{8}$	4.5	4.5V	400	£11.11.0	Consists of two Unimite Servos mounted on vibration proof P.C. installation board, complete with relay and ready wired. May be operated from any simple relayless receiver

AROUND THE WORLD

Country	*Frequencies (Mc/s.)*					*No. of FAI Licensed R/C Flyers*
9 Italy	27					Under 100
10 Czech'vakia	27·120		40·68	120		Under 100
11 Hungary		28–29·75			144–146	Under 100
12 Poland	27·12 ± 0·05					Under 100
13 Finland	27·12 ± 0·6%					Under 100
14 Denmark	27					Under 100
15 Norway	27					Under 100
16 Russia	27					Under 100
17 Turkey	27·12		40·68			Under 100

SINGLE CHANNEL FLYING

BY

KEN WILLARD

By arrangement with Top Flite Models

Champion of the single channel "Sunday flier," Ken Willard is seen here with scale S.E.5a and Spitfire which he converted to R/C from rubber power kits. Text taken from Ken's "How to fly R/C Compacts" manual supplied with all Top Flite R/C compact kit designs.

Before flying your model there are several things you can do to assure success.

Before you leave home for the flying field, follow the manufacturers' instructions, and check your transmitter and receiver batteries *under load* to be sure that the voltages are at a safe operating strength because battery complements vary with individual makes of radio equipment, you can make sure all batteries are under load by turning on both receiver and transmitter and holding a signal while the voltage is measured. Take the reading over a period of at least 15 seconds to make sure that, in the case of well-used batteries, no fast and continuous falling off of voltage is noticeable.

To make a reliable range check when the receiver has not been well tuned, have a helper hold the transmitter while you walk out the model for tuning (Fig. 1). Tuning close by is not enough because the transmitted signal is relatively strong for the short distance involved and tuning will seem 'broad" and easy. However, as distance is increased between transmitter and receiver, tuning will become narrower (less turning movement of your tuning tool) until reception is good only at one precise position of the tuning device in your receiver. So moving the receiver away by several hundred feet enables you to tune more precisely, avoiding the risk of lost control to poor tuning.

You will need a system of hand signals to indicate to the helper what you wish him to do. An upraised arm (held overhead) means hold signal on while I tune (Fig. 2). After that, an arm raised to shoulder height indicates put signal on; when arm drops, signal off. (Figs. 3 and 4.) This permits you to order rapid signals as required. Wave your arm from side to side to indicate when to shut off transmitter.

Incorrect size of rubber escapement motor is a common cause of escapement problems. Be sure to use the recommended size of rubber, and allow at least 10% extra length to

avoid excessive tension between hooks. Treat the rubber with rubber lubricant or, if unobtainable, try castor oil. (Never use motor or mineral type oils), then wipe off excess.

When winding the rubber, note that it first twists for its entire length, then begins to build a row of knots from hook to hook. Count the turns as you wind (the gear ratio of your winder, such as 4 to 1, will help you count) and check to see if the escapement continues to operate at, say 20% more turns after the row of knots has been attained. If so, limit yourself to somewhat less turns than this excess. Between flying sessions it is a good idea to unwind the rubber motor.

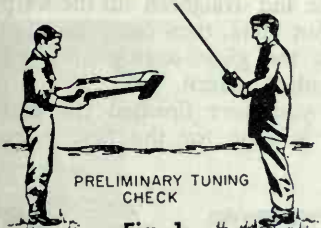

PRELIMINARY TUNING CHECK

Fig. 1

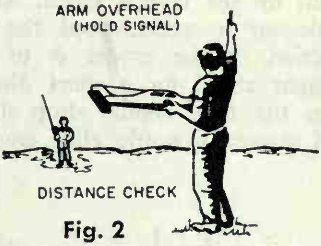

ARM OVERHEAD
(HOLD SIGNAL)
DISTANCE CHECK

Fig. 2

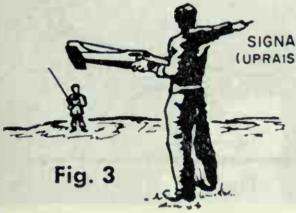

SIGNAL ON
(UPRAISED ARM)

Fig. 3

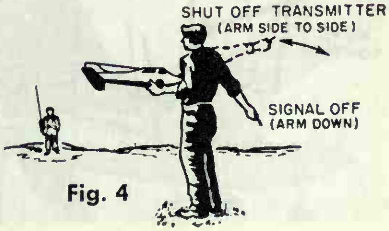

SHUT OFF TRANSMITTER
(ARM SIDE TO SIDE)
SIGNAL OFF
(ARM DOWN)

Fig. 4

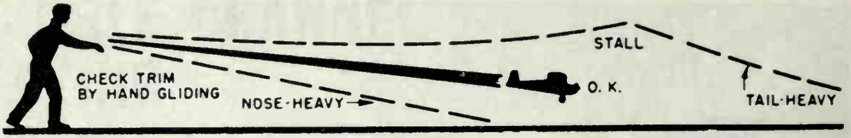


Fig. 5

Flying

Find yourself a large vacant space of field overgrown with tall grass. I know this is the same advice you have been told since you started building models, but this time I am suggesting it from the viewpoint of radio jobs rather than free flight. Remember, tall grass is not much of a cushion for a 5 lb. model, but it will save a good deal of minor repair work on a 10 oz. job.

Let's go through the test gliding sequence. Launch the model into wind (and do not carry out this test unless the wind is light). Launch the model level, or even with the nose slightly down, but never heave it up into the air! Try to estimate the speed of release to roughly equal the normal gliding speed of the model (somewhere around 15–18 m.p.h.). Launch the model slowly at first and gradually build up the launch speed. As you come up to glide speed the ideal reaction of the model is to glide straight ahead for a short distance, then the nose should drop slightly and assume a gentle glide angle, at which angle the model should sink to the ground. (Fig. 5.)

If the model noses up, stalls, and drops, then check two things. First, is your C.G. where it belongs? If not, move the batteries forward as required. If however, the C.G. is correct then check your elevator. Correct by bending the adjustment wire, or by shimming ($\frac{1}{64}$ in. at a time). It may take a combination of both corrective actions.

If the model dives into the ground, even though you launch it faster than glide speed, then move the batteries back, or bend the elevator adjustment spring up a little—$\frac{1}{32}$ in. at a time.

If any tendency to turn is noted on the glide, check wing, tailplane and fin for warps. Also make sure the rudder is straight. Do not try to overcome any warps by using opposite rudder—this could be fatal when you apply power. Go home and straighten out the warps over a hot plate, then come back and continue the glide testing until you achieve ideal pattern.

Now you have finished the glide tests it is time for the first power

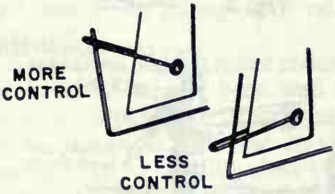


Fig. 6

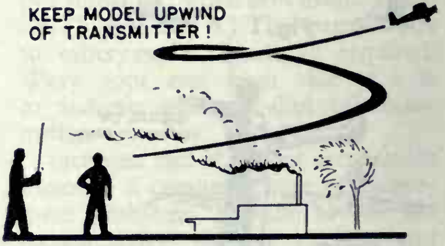
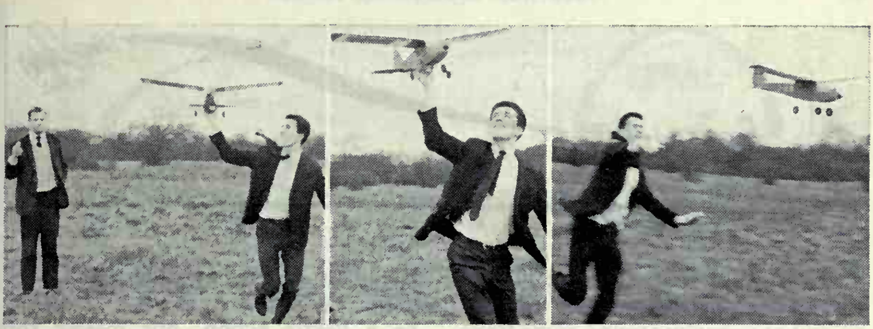


Fig. 7



Hand launch technique with power on. Pilot first checks correct operation of controls. Then launcher runs into wind. As the wings begin to show signs of lift the launch follows through, releasing model in a slightly downward attitude.

flight. Set the rudder yoke down to minimum travel (Fig. 6), also the elevator yoke if you are using one. (The elevator ordinarily is not required except when you want to stunt the model.) Check out the radio range. Put in enough fuel for a short flight—about a minute or so.

As a novice you should avoid windy days. A model can drift with a strong wind for long distances if you lose control through inexperience. Since the glide speed of the model is in the vicinity of 15–18 m.p.h. it is obvious that, for a small model, a 15 m.p.h. wind is quite strong (too strong for the novice). As you gain experience you will note that it is always much harder to control the model properly when it gets downwind from you and therefore it is always best to endeavour to position the model upwind (Fig. 7) where mistakes will not put pressure on the pilot. If too far downwind, a mistake can mean lost control despite perfect operation of the radio.

After starting the engine and adjusting for peak power, turn on your receiver and transmitter and make a

Winding the rubber motor. Carefully count the turns as they are wound on to obviate the risk of breaking the rubber.

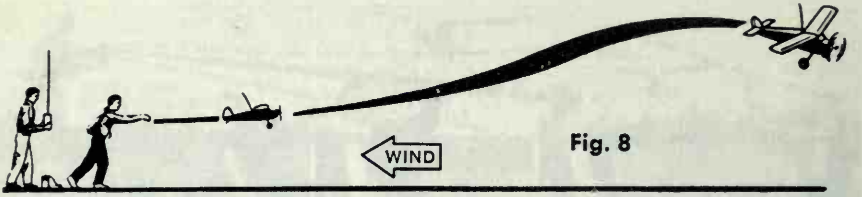


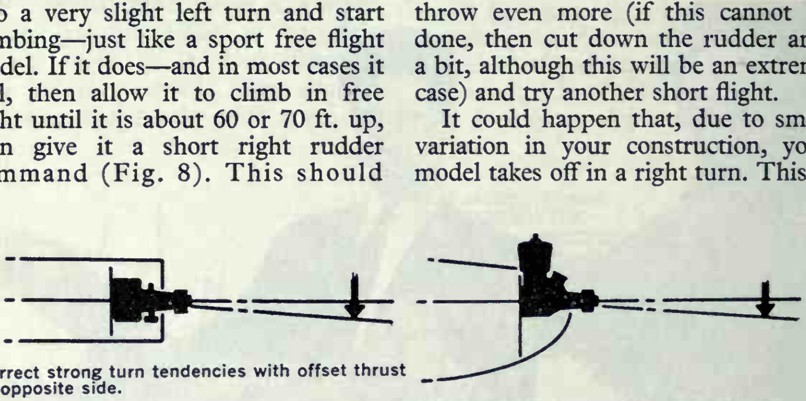
Fig. 8

final control, check. When doing this you may require help. When switched on and at very close range, some transmitter/receiver combinations tend to "swamp" the receiver so that it does not work properly, often causing the receiver to "lock-on," resulting in locked control. If this happens you have to move the transmitter away from the receiver far enough to overcome this tendency. In any event, before launching your model, key the transmitter and be sure the control surfaces respond properly. Yes you did it at home—but do it before every flight. Once you have made absolutely sure everything is working, launch the model—or let it take off. If the former is the case, launch it straight ahead and level into wind. Do not heave it up!

If you have carried out your glide tests carefully, the model should go into a very slight left turn and start climbing—just like a sport free flight model. If it does—and in most cases it will, then allow it to climb in free flight until it is about 60 or 70 ft. up, then give it a short right rudder command (Fig. 8). This should straighten the flight path out and steer the model into a right turn. It should be a gentle action, but release the signal as the model goes into the right turn or the nose will drop. Let the model recover by itself into the gentle climbing turn to the left. Now you can experiment a little—a couple of right rudder commands in sequence, may be enough to complete a right hand circle. Try not to hold any signal so long that the model drops its nose down too far and picks up speed. This usually confuses the beginner and he tries to correct, only to make it worse.

If, when you give right rudder command, the model rocks violently over then let it alone. This is where that short motor run comes in handy—you did meter the fuel didn't you? Chase it á-la-free flight, and when it glides to earth, take it back to the launch area and reduce the rudder throw even more (if this cannot be done, then cut down the rudder area a bit, although this will be an extreme case) and try another short flight.

It could happen that, due to small variation in your construction, your model takes off in a right turn. This is



Correct strong turn tendencies with offset thrust to opposite side.

Add downthrust to correct looping tendencies.

Fig. 9

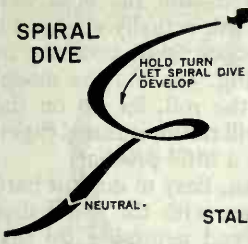

SPIRAL DIVE
HOLD TURN LET SPIRAL DIVE DEVELOP
NEUTRAL

Fig. 10

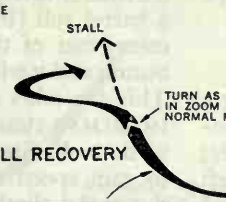

STALL
TURN AS SPEED DROPS IN ZOOM TO RECOVER NORMAL FLYING SPEED
STALL RECOVERY
EXCESS SPEED FROM SPIRAL DIVE CAUSES ZOOM AFTER NEUTRAL

Fig. 11

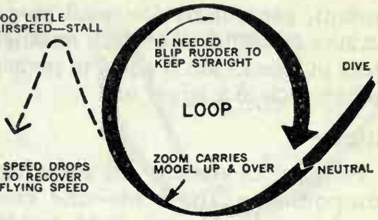

TOO LITTLE AIRSPEED—STALL
IF NEEDED BLIP RUDDER TO KEEP STRAIGHT
DIVE
LOOP
ZOOM CARRIES MODEL UP & OVER
NEUTRAL

Fig. 12

not serious, unless the turn tightens up. If it does, you will have to let it circle down until it hits the ground or try to correct with left rudder. This is a little hard for the beginner, because the excitement usually is too much, and instead of pushing the button twice, he hits it once—and that is pretty hard to bungle.

Perhaps the most conservative way for someone who has never pushed a transmitter button in ernest before, but has flown free flight, is to make all flight adjustments with short free flights. (In this case limit the fuel to suit your field, perhaps as little as 15–30 seconds.) Keep your radio on anyway, but do not use it except in dire emergency. Make short flights until you get the flight pattern set—left turn under power, right turn on glide. Most of you know how to do this, adjusting the thrust line (Fig. 9) or rudder, but here is a brief summary anyway.

1. Model climbs to left, glides left. Adjust rudder slightly to right.
2. Model climbs to right, glides to right. Adjust with slight left rudder.
3. Model circles tightly to left under power, glides straight or to right. Put in slightly more right thrust.
4. Model circles to right under power, glides straight or to left. Takes out a little of the right thrust.
5. Model glides fine, but swoops under power and tends to stall. Add a little down thrust.
6. Model glides correctly, but dives in under power. Take out some down thrust (this is rare with small models).

All the above adjustments assume that you have removed any warps, and your wing, tailplane and fin are properly aligned. This is very im-

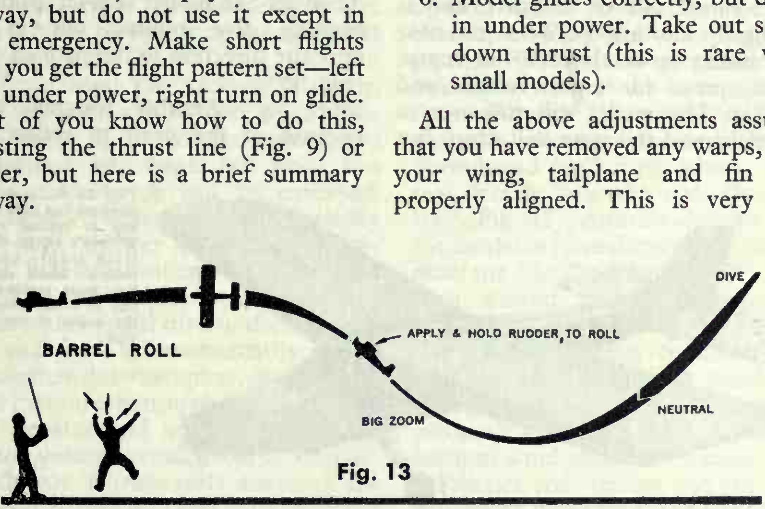

DIVE
APPLY & HOLD RUDDER TO ROLL
BARREL ROLL
NEUTRAL
BIG ZOOM

Fig. 13

portant, particularly for small models because an eighth of an inch misalignment in a small job is equal to perhaps half an inch in a larger one.

Stunts

First, let us assume you are using a compound escapement—one command and hold gives right rudder; two commands and hold gives left rudder. We will skip the "kick-up" elevator for the moment, since some do not have this feature. Later on we will introduce it.

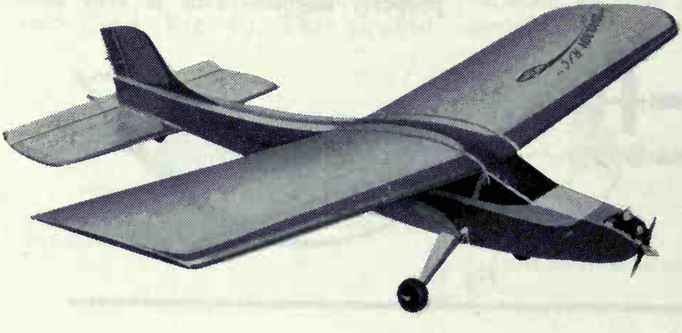
SPIRAL DIVE. Easy, just achieve plenty of altitude, push the button on the transmitter and hold it down. The model will start a right turn, the nose will drop and down she comes spiralling tighter and tighter, the longer you hold on control (Fig. 10). To recover, just release the button, the excess speed will pull the nose up automatically. You can then turn out of the ensuing stall, (Fig. 11) or, if you have built up enough speed, the model will go up and over into a loop (Fig. 12).

BARREL ROLL. A little tougher. Start with a spiral dive to build up speed. Neutralise and wait until the model has zoomed out of the dive and is nosing up into a loop. When the nose is pointing up at about 45–50 degree angle, press for right rudder and h-o-l-d. The model will roll over to the right and the nose will drop, but since you started with the nose well up, the model will actually spiral in a horizontal direction, thus resulting in a barrel roll (Fig. 13). As the model comes out of the roll, let up on the button and it will resume normal flight. This one takes a little practice.

IMMELMAN TURN. Easy to do, but hard to do well. Start with the spiral dive to gain speed and neutralise, so that the model climbs up and over onto its back. When it is upside down, press and hold rudder and the model will roll out of the loop on top, thus completing the Immelman turn (Fig. 14). The trick is in pressing the button just at the right time—also in the right direction. This last trick is important.

WINGOVER. Difficult. Requires practice, because speed is a critical factor. Start with spiral for speed, picking up just enough speed for the model to recover into the vertical stall position. Not too fast though or the model will continue up over the loop. When the model is pointing practically straight up, press rudder; the model should fall over on the wing, at which point you release the rudder command as the nose re-directs towards the ground. Then let the model recover from the ensuing dive—pulling out in the opposite direction to the path of entry (Fig. 15).

SPLIT "S." Another toughie, again because of the need to judge your



This 29 in. span, 0·020 powered Top Flite Schoolboy is typical of Ken Willard's range of small field single channel models. Small size and low mass minimise the risk of crash damage at the hands of the novice pilot.

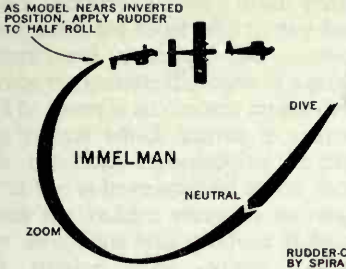

AS MODEL NEARS INVERTED POSITION, APPLY RUDDER TO HALF ROLL
DIVE
IMMELMAN
NEUTRAL
ZOOM

Fig. 14

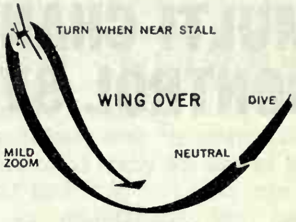

TURN WHEN NEAR STALL
WING OVER
DIVE
MILD ZOOM
NEUTRAL

Fig. 15

RUDDER-ONLY MANEUVERS ARE STARTED BY SPIRAL DIVING TO GAIN EXCESS SPEED. AMOUNT OF SPEED DETERMINES EXTENT OF MANEUVER.

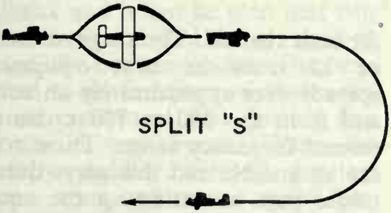


Fig. 16

LANDING APPROACH PATTERN

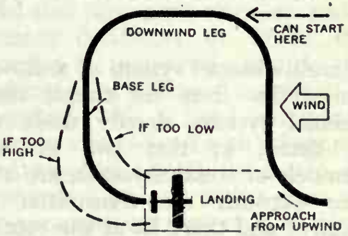

DOWNWIND LEG
CAN START HERE
BASE LEG
WIND
IF TOO LOW
IF TOO HIGH
LANDING
APPROACH FROM UPWIND

Fig. 17

speed. Start with a spiral, build up speed, then, on the recovery, zoom into a 50 degree climb, signal rudder as per barrel roll, and roll her to inverted. Then neutralise control and allow the model to recover through a half loop (Fig. 16).

There are a few manoeuvres you can achieve by operating the rudder at the right time.

If you install the "kick-up" elevator, you will need a little more practice on the button to be sure that you get the command you want, but once you have used it you will be enthused.

Manoeuvres are tackled in basically the same manner as without "kick-up," but now you can do them a lot faster. For example, on the loop, you start with a spiral dive to the right, let up and press left momentarily just to straighten out the spiral, then let up and press the button the third time for up elevator and you have the loop faster without so much loss of altitude.

LANDINGS. During early attempts, the beginners may find that landings occur rather far away from the transmitter. In time you will learn to position the model in the air with respect to an intended landing spot so that reasonably accurate approaches can be executed, always. A good method of achieving this is to hold the model upwind and if possible, high enough to set up a typical "full-scale" approach pattern. By flying downwind off to one side try to make it the same side each time, although either side will do if obstacles dictate, you will have a "downwind leg" from which, like a real aircraft, you turn onto the "base leg" (Fig. 17). Altitude dictates when the model is turned out of the base leg onto the "landing approach." If too high, extend the base leg to lose altitude, if too low, cut the base leg short. In very windy conditions, just line the model up into wind high enough and near enough so that it can settle at a steep angle as you hold her into wind with rudder corrections.

Practice your timing and very soon you will be flying with the best of them!

MULTI CHANNEL CONTROL SYSTEMS

A multi-channel system of radio control differs from the simple single-channel system already dealt with in detail, in that two or more channels of communication are available between the transmitter and receiver and there is, at the receiver, some device to act as a discriminator between the signals that carry the required intelligence on each channel. Having identified the incoming signal the second function of the discriminator is to pass it on to the correct servo. The most popular number of channels in multi has been established at ten as this gives all the controls required to fly a full aerobatic pattern. The maximum is twelve, the additional two channels being used for a possible supplementary function. Of these, it is possible to transmit two signals simultaneously although limitations in the equipment will only allow certain combinations of control command to be sent at the same time. Ten and 12 channel transmitters are so arranged, therefore, as to give the most useful combination of simultaneous control. Simple multi-channel systems having only four, six, or more rarely eight channels, are also made.

The transmitted signal is a tone modulated carrier, similar in character to that of the single channel equipment, and the differentiation between one channel of command and another is achieved by having a different tone for each channel. The range of the ten or 12 tones in most equipments spreads over approximately an octave and is in the 350 to 700 cycles per second frequency range. These tones are all audible and this plays quite a useful part in setting up the equipment and carrying out simple checks on its operation and adjustment.

Modern transmitters are all fully transistorised and are hand held. Most are fitted with whip aerials about 4 ft. long which are brought to a resonant electrical length by either base or centre loading. The block schematic on page 44 gives a typical transmitter layout. We will discuss transmitter function in greater detail later.

Receivers for multi-channel are mostly superhets as this circuit confers the benefit that up to six equipments can be operated at the same time as long as they are each on a different one of the six available spot frequencies in the 27 Mc/s band. These frequencies are 26·995, 27·045, 27·095, 27·145, 27·195 and 27·255 megacycles per second. All superhet receivers are essentially crystal-controlled. It is the high degree of selectivity of the superhet together with the provision of the six crystal-controlled spot frequencies within the band, that enables any number of models up to a maximum of six to be flown at once. Modern superhet receivers are universally relayless.

To complete our multi-channel equipment we must add to our transmitter and receiver the necessary servos to operate the control surfaces.

The servo is an electric motor driven mechanism which moves in either of two directions according to the polarity of the voltage applied to the motor. Thus the rudder servo in moving in two directions will produce right and left rudder. The polarity of the applied voltage is controlled by the reedbank and it can be seen that two channels of command are required to produce the two movements. The same applied to all functions so that a ten channel equipment will provide five controls in the aircraft. These are normally rudder, aileron, elevator, elevator trim, and engine speed control.

The circuitry in the servos can be arranged so that they will automatically return to an established "neutral" or centre position if no signal is transmitted. These are designated "self-neutralising" and a given command is only held as long as the appropriate signal continues to be transmitted. The alternative circuitry provides that the servo does not self-neutralise in the no-signal condition so that it can be moved to, and left in, any desired position, and there is no established neutral. Because servos with this function are normally used for trimming a control surface or for pre-setting the engine throttle control they are referred to as "trim" servos.

A glance at the simplified schematic diagram on page 44 will show that the transmitter contains five main sections, the function of each of which can be considered separately.

The R.F. oscillator generates a high frequency carrier which is crystal-controlled. The crystal used will be one of a matched pair, the other being used in the matching receiver. R.F. oscillator design presents no particular difficulty and a high degree of stability is obtainable without undue complication. The output from this circuit is a radio frequency oscillation of constant amplitude and frequency.

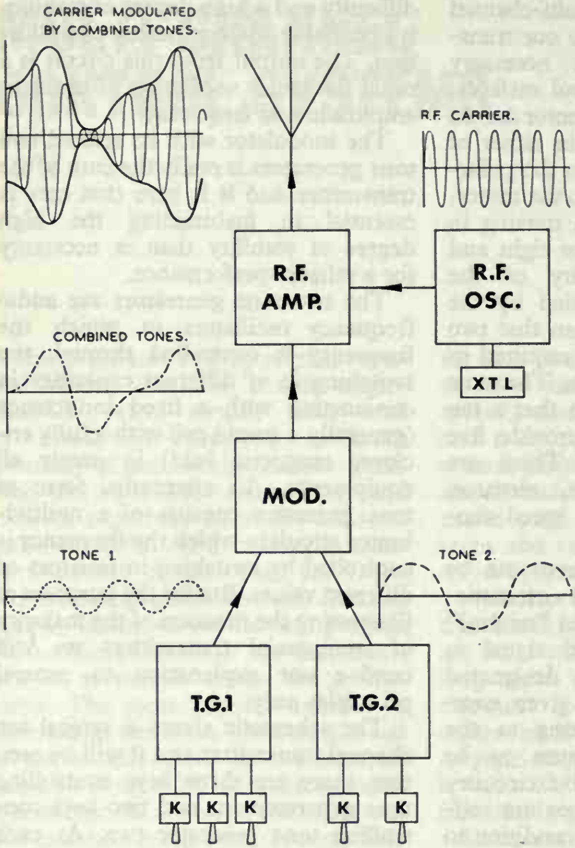
The modulator with its related two tone generators is really the core of the transmitter and it is here that care is essential in maintaining the high degree of stability than is necessary for a reliable performance.

The two tone generators are audio frequency oscillators in which the frequency is controlled through the switching in of different capacities in conjunction with a fixed inductance (generally a toroid coil with a fully enclosed magnetic field) in nearly all equipments. An alternative form of tone generator consists of a multivibrator circuit in which the frequency is controlled by switching in resistors of different values. But for the purposes of illustrating the function of the majority of commercial transmitters we will confine our explanation to general principles only.

The schematic shows a typical ten channel transmitter and it will be seen that there are three keys controlling tone generator one and two keys controlling tone generator two. As each key has two positions it will control the production of two tones. Generator one will, therefore, produce six tones and generator two, four making our total of ten.

It is to achieve the bi-simul function that two tone generators are necessary and the function of the modulator is to accept the tones and pass them on to the main R.F. amplifier.

Any tone from generator one can, therefore, be used in conjunction with any tone from generator two, and the modulator combines these and passes them on as a complex of the two during simultaneous working. The wave-forms on the schematic illustrate an example in which the first tone is



R.F. OSC.—Radio frequency oscillator crystal controlled.

R.F. AMP.—Accepts the R.F. and modulating frequencies and combines them as well as increasing signal strength before feeding into the aerial.

MOD.—The modulator which generates the "tone" or modulating frequency to be superimposed on the carrier. Also includes circuitry which enables two tones to be combined together to produce simultaneous modulation.

T.G.1 and T.G.2—The tone generator switch and low frequency oscillators. They produce tones which are controlled by the keying switch being operated. As each key has two positions T.G.1 will produce six tones and T.G.2 four. Any one frequency from T.G.1 can be combined with any one tone from T.G.2 for simultaneous operation.

the second harmonic of tone two with which it is combined to become the complex wave-form shown being fed into the R.F. amplifier.

This complex wave-form is utilised within the R.F. amplifier to modulate the R.F. or carrier wave with the result that we get the output to the aerial as shown in the schematic. In the event that only one tone is being transmitted at a time then the modulated carrier will only be modulated by the one tone. (N.B. in the schematic all tones are shown as being pure sine wave in form which in fact the tones in multi equipments never are. But they serve to show more clearly the principle of the combination of tones during the bi-simul function.)

The arrangement of the control switches on commercial transmitters has become standardised and is as follows:

Top right, aileron; bottom right, rudder. Top left, engine speed; bottom left, elevator; and to the right of or just below the elevator switch we have elevator trim. In the case of 12 channel equipments the switch for the supplementary function is always on the right so that each tone generator now produces six tones.

All switch movements correspond in a logical manner with the corresponding control surface movement. Thus the aileron and rudder switches always move right for right turn or roll, and left for left. The engine speed switch moves up for high speed and down for slow. The elevator is the only one which at first appears to have a reverse movement in that the switch must be moved "up" for down elevator and vice versa, but in this case the switch movement corresponds to the equivalent control column movement in a full-sized aircraft in which the stick is pulled back, *i.e.* down, in order to pull the nose of the aircraft up. Therefore stick back (switch down) means up elevator.

We must now consider the working of the matching superhet receiver and determine how the transmitted intelligence is finally conveyed to the servo mechanism so as to produce the desired control.

When any two frequencies are combined the resultant is again two frequencies one of which is the sum of the two original frequencies and the other the difference. In the superhet receiver it is the difference frequency obtained from such a combination that is used.

The incoming signal, which is in the 27 Mc/s band, is combined with a locally generated oscillation of a different frequency, the frequency of the combined signal being the difference between that of the incoming signal and the local oscillation.

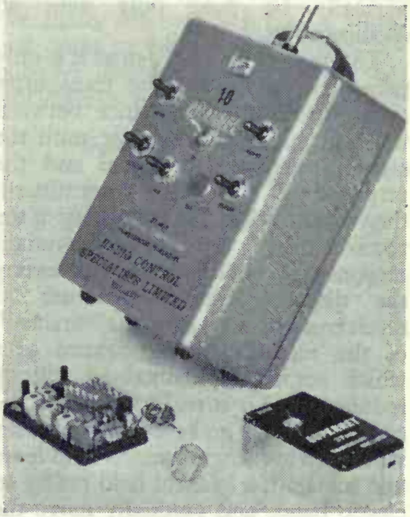
The incoming signal is first amplified then passed on to the next stage called the mixer where it is "heterodyned" with the signal from the local oscillator whose frequency is exactly 455 kilocycles lower than that of the incoming signal. Thus if your transmitter is crystal-controlled to 26·995 Mc/s per second then the local oscillator will be crystal-controlled to 26·540 Mc/s per second and the resultant signal will be at the intermediate frequency of 455 kc/s per second.

The tone that is carried by the incoming signal will be superimposed on the newly created intermediate frequency which is passed on to the intermediate amplifiers from the mixer. There are two stages of intermediate amplification in the average superhet receiver.

After the two stages of intermediate amplification the signal is rectified by the detector stage and finally passed on to the audio or output amplifier whose function it is to "drive" the reedbank.

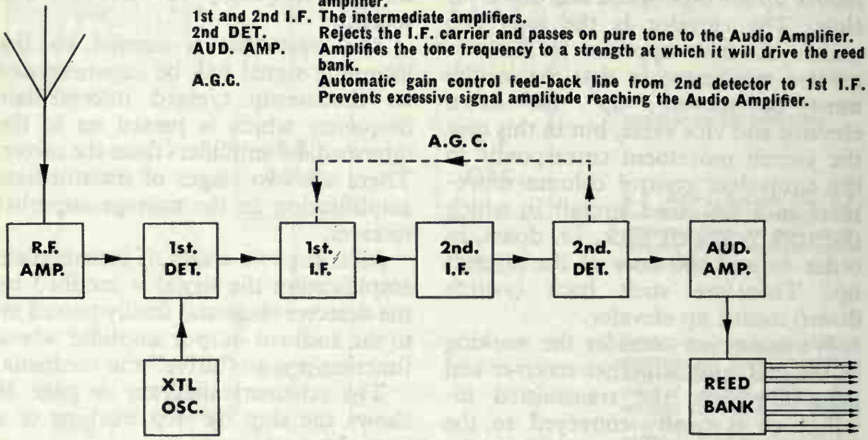
The schematic diagram on page 46 shows the step by step working of a typical superhet receiver.

Let us now consider the tuning procedure for a superhet. The tuning control made available to the owner is exposed through a hole in the top or side of the receiver case and tunes the R.F. amplifier, *i.e.* the amplifier that increases the strength of the incoming



Modern reed type multi systems employ superhet receivers and all transistor transmitters. A typical unit is the R.C.S. Competition 10 seen at left. Note layout of transmitter keying switches as referred to in text.

R.F. AMP.	**Amplifies the incoming signal at radio frequency (27 Mc/s.) before being fed into 1st detector.**
XTL OSC.	**Generates the local oscillation at the R.F. frequency minus 455 Kc/s. Incoming signal is heterodyned with this oscillation in next stage.**
1st DET.	**Sometimes called the mixer. Accepts the incoming R.F. signal and heterodynes it with the local oscillation. Passes on the intermediate frequency which is now acting as the carrier for the "tone" to the 1st I.F. amplifier.**
1st and 2nd I.F.	**The intermediate amplifiers.**
2nd DET.	**Rejects the I.F. carrier and passes on pure tone to the Audio Amplifier.**
AUD. AMP.	**Amplifies the tone frequency to a strength at which it will drive the reed bank.**
A.G.C.	**Automatic gain control feed-back line from 2nd detector to 1st I.F. Prevents excessive signal amplitude reaching the Audio Amplifier.**



signal before passing it on to the mixer.

Each intermediate amplifier stage has a transformer which can also be tuned to the intermediate frequency by means of a slug. But the procedure here is not as simple as it is with tuning the first stage and should normally be done only with an oscilloscope.

To tune the first R.F. stage it is only necessary to remove the transmitter aerial, increase the distance between the transmitter and receiver until the signal strength is marginal and the response of any servo intermittent, then carefully bracket the tuning of the receiver slug until the maximum response is obtained. By increasing the distance from transmitter to receiver a little at a time the "bracket" of the receiver tuning control over which control is maintained will be reduced until it is really small and the tuning sharp. The best way to do this when you are single handed is to leave one transmitter control held on by an elastic band, and gradually move the receiver away carrying out the bracketting tuning procedure at increments of about 6 in. increase in distance. An average range on the bench carried out like this with no Tx. aerial and the receiver aerial coiled up on a loop of about 2 in. diameter is from 10–15 ft.

Tuning the I.F.'s or lining up the I.F.'s as it is more generally known *can* be done by listening to the singing of the reeds on the reedbank. But this is not nearly so positive a method as using an oscilloscope and it is definitely NOT recommended.

To line up the I.F.'s with an oscilloscope use the following procedure. Tune the R/C amplifier as described above first. Connect the input lead of the oscilloscope to the output lead of the receiver, *i.e.* to the lead that goes to the non-earthy end of the reedbank coil. On some receivers (Orbit is an example) there is a special lead known as "receiver test" which is specially provided so that this connection may be easily made. The earthy lead from the oscilloscope should be connected to the chassis of the receiver. With one transmitter signal held on as before adjust the oscilloscope gain control to give a picture not exceeding half the screen height in amplitude. Now carefully tune all the I.F. cans in turn to give the maximum amplitude of signal on the scope. Should the amplitude increase so much that the wave-form goes off the tube top or bottom (or both) just reduce the oscilloscope gain and carry on. It is best to go back and forth over the I.F. cans carefully until the best result is obtained as in some circuitry the adjustment of one I.F. can may be reflected in another. In fact the tuning procedure is extremely simple as long as you have the necessary equipment. If you haven't and you think your receiver needs re-lining or tuning, better take it to someone who has.

With the receiver correctly tuned there is only one other adjustment that can be made and that is the contact gap on the reeds.

The principle on which the reedbank or reed relay works is that a resonant reed, which like a tuning fork has a natural frequency of vibration, has a maximum response to its resonant frequency which falls off rapidly when the frequency to which it is subjected rises above or falls below resonance. See diagram on this page.

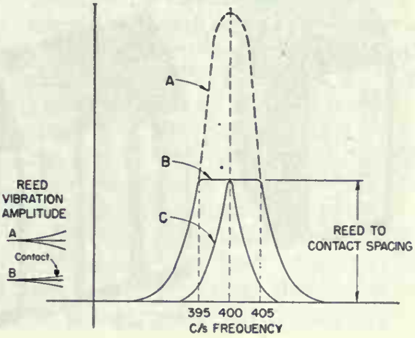
In the reedbank the reeds are made of magnetic material, a high grade of spring steel strip, and they are arranged so that the end of the reed is in the magnetic field of an electro magnet. When an alternating current is fed through the winding of the electro magnet then only that reed which has a resonant frequency the same as that of the frequency of the applied alternating current will be made to vibrate. Typically the ten reedbank has ten reeds whose resonant frequencies lie between 350 and 700 cycles per second, all being equally spaced throughout the frequency range rather like the notes of the musical scale.

Reverting to transmitter operation and tuning for a while therefore let us examine how we match the transmitted tones to the receiver.

In the whole control system the tone frequencies are predetermined by the resonant frequencies of the reeds in the reedbank, and these are not, in fact, designed to be adjustable. In tuning the transmitter we are, in fact, adjusting the tones generated for the purposes of modulation so that they match exactly the resonant frequencies of the receiver reeds.

Each tone is "tuned" by means of a potentiometer and the circuitry generally provides that a rise in frequency is obtained by a clockwise turning of the pot. When tuning the transmitter tones it is better to have all servos disconnected so the vibrations of the reeds can be clearly heard. On operating any transmitter control the corresponding reed will be heard clearly vibrating. Turning the appropriate potentiometer clockwise will cause an audible rise in frequency, and eventually the reed will go "of song" and cease to vibrate. On turning the pot *very slowly* anti-clockwise the reed will again commence to vibrate and the

Typical reed response curve when unrestricted by contact.

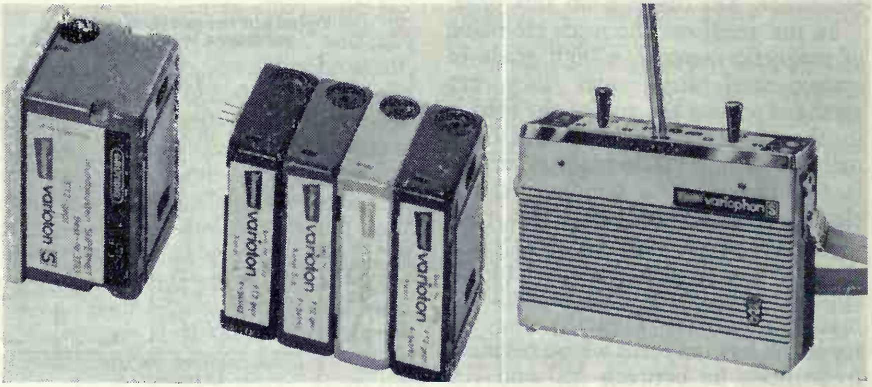


optimum tuning point is generally to be found the mearest fraction of a turn further anti-clockwise than the point at which vibration once more comes in. Only practice will teach you just how to tune your own transmitter, but the principles of tone tuning are much as laid down here for all transmitters.

Once all the transmitter potentiometers are tuned to the optimum position where the required response is obtained from all the reeds, there should not be any "cross-talk" between reeds, *i.e.* when any one reed is vibrating the reed either side of it should not vibrate at the same time.

Having achieved correct tuning the only remaining receiver adjustment to obtain correct functioning of the servos is the contact between the vibrating reed and the adjustable contact above it. These gaps are correctly set by the manufacturer of the receiver and do not generally require adjustment except as previously mentioned. The first thing to suspect if any servo refuses to work either one way or the other is that the contact area between the appropriate reed and its fixed contact has become dirty. It is easily cleaned by drawing a small piece of clean good quality paper between reed and contact while pressing the reed gently up against the paper so as to create light pressure over the contact area on both sides. Doing this once or twice will usually restore good contact where the fault was soiling of the surfaces. If the servo works, but does so jerkily or intermittently this may be due to the gap being too large resulting in irregular contact. The gap may be closed by screwing down the adjustable fixed contact, but in no circumstances should this adjustment be made more than a quarter of a turn at a time. If you finish up after adjustments with one reed gap noticeably smaller than all the others suspect that there is something wrong other than the adjustment. A bent reed can be the cause of this maladjustment becoming necessary in which case the reed should be very carefully restored to its original condition, and this is a job which it is strongly recommended you leave to an expert.

It will be appreciated that the contact between the reed and its fixed contact is intermittent. In fact the contact will only be made for a very small fraction of the total time during which it is vibrating. Such an interrupted contact would not be a satisfactory one for carrying the working current for the servo amplifier it must



This Grundig tuned filter set has a superhet receiver at left with plug in twin channel filter modules. The stack here provides eight channels. Transmitter is very attractively packaged.

switch on, and the reed gap is, therefore, bridged by a large capacitor which charges up during the open period thus maintaining the flow of current to the servo. When the reed closes the capacitor becomes discharged while the closed reed gap carries the servo current. Although not a truly non-fluctuating D.C. current, the resultant is near enough to a constant current to maintain the servo's requirements.

We must now examine a typical servo and for the purpose of our explanation we have chosen the Bonner. The Duramite version is designed to work with a relay receiver and the pair of relays for each servo act as battery switches and connect the battery to the servo motor so as to produce the required movement in either direction to give left and right or up and down as the case may be.

In the case of the Transmite, the servo incorporates its own six-transistor amplifier, the input stage of which is fed by impulses from the reeds, and the output stage of which can be regarded as a power amplifier with sufficient current carrying capacity to drive the servo motor.

Established as the most popular of all multi-servos and having earned a reputation for reliability and performance, the Transmite incorporates all the essential features of a successful servo.

Basis of the Transmite is the very efficient small electric motor which driven by the servo amplifier is coupled mechanically through a train of gears giving a reduction to a quadrant. On top of the quadrant and projecting through the top of the servo case is an arm with a screw thread adjustment to which is coupled the control surface. This arm moves through an arc of about 40 degrees which is the equivalent of a near linear movement of $\pm \frac{5}{16}$ in. about a predetermined central or neutral position.

Control of the limits of movement at either end is obtained by contacts attached to the moving quadrant that move over a printed circuit board on which the contact strips are arranged so as to break the circuit when the desired limit of movement has been reached. In the case of a self-neutralising servo the circuitry must also be arranged so as to drive the motor in the reverse direction to obtain the required return to neutral. This is a function of the servo amplifier and we shall examine this more closely later.

Reverting to the Duramite let us examine how the relays in conjunction with the printed circuit produce the self-neutralising function of the servo. Each relay acts as a single pole double throw switch (S.P.D.T.) and the servo switching board is connected to a centre tapped battery through these relays so that the polarity of the voltage applied to the servo motor can be reversed, thus driving the motor in either direction. The limit of movement in either direction is controlled as we have already seen by the movement of the wiper contacts on the quadrant over the printed circuit switcher board, the required control movement is obtained when the relay working or normally open contact is closed on receipt of a signal and the return to neutral is obtained by the action of the back or normally closed contact on the relay.

The switcher board is almost exactly the same in the Transmite as in the Duramite, and all that is necessary to convert to relayless operation is to fit the servo with the amplifier which takes the place of the relays and fulfils their switching function.

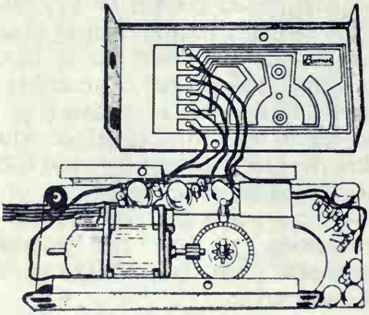
Without going into too detailed an explanation of how this amplifier works, the principles should, we feel, be understood.

The output stage consists of two power transistors which can, in turn, connect the servo motor to either half of a centre tapped battery in much the same manner as the relay contacts. Both these transistors are normally non-conductive.

When a D.C. pulse is received from the yellow reed, it is fed to the base of transistor VT1, through the filter circuit C2 and R1 whose time constant is such that the input signal is smoothed right out. Similarly the same input pulse is fed to the base of transistor VT3 through the filter network C2 and R7.

When the opposite sense signal is received from the orange reed, it is filtered through C1 and R5 to the base of transistor VT2 and by C1 and R6 to the base of VT3. VT3 is made conductive when a signal is received either from the yellow or orange reed, and as a result, the neutralising transistor VT4 is cut off, *i.e.* rendered non-conductive. VT4 is normally conductive and in the "no signal" condition it supplies approximately 50mA base current to either VT5 or VT6 to return the servo to the neutral position by driving the servo motor in the reverse direction to the "signal on" state.

VT1 amplifies the filtered input signal from the yellow reed (approximately 3mA), and supplies approximately 50mA to the base of the power transistor VT5 which in turn drives the servo motor. The maximum current carrying capacity of VT5 is of the order of 1 ampere, but the normal current required by the motor should not exceed 250mA or possibly 500mA in the stalled condition, should that arise.



Installation of Transmite amplifier in Bonner servo also showing connections to the printed circuit wiper plates.

Similarly VT2 amplifies the filtered input signal from the orange reed, supplies approximately 50mA to the base of power transistor VT6, which in turn feeds the motor but in the opposite direction to VT5.

Thus it will be seen that, in the rudder servo for example, VT5 will drive the servo to (say) left rudder, VT6 to right rudder, and VT5 will return the servo to neutral from right rudder and VT6 to neutral from left rudder.

It is the voltage developed across resistors R2 and R4 that bias transistors VT1 and VT2 off when no signal is being received. R3 acts as a limiting resistance that keeps down the value of the current that has to be carried by VT1, VT2, VT3 and VT4 and it also serves to increase the reverse bias on VT1, VT2 and VT3 in conditions of leakage.

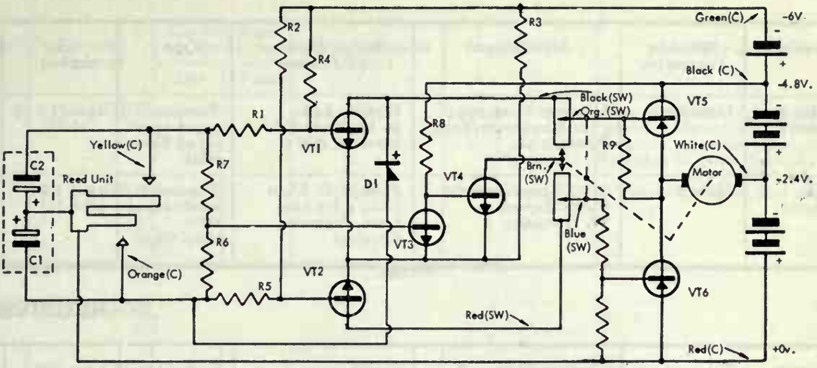
R8 is the collector load resistor for VT3.

R9 and R11 bias off VT5 and VT6 during "no signal" periods.

R10 is a limiting resistor to prevent the base current of VT6 rising to too high a value.

D1 is a diode which has been added to the original circuitry of the Transmite amplifiers to prevent damage to the unit, should both the yellow and orange reeds come in together, thus producing a short circuit.

The push rods from the servos to the controls are made from hard square section balsa wood with clevis



Bonner Transmitter Amplifier Circuit and Component Values

R1 : 1·2k
R2 : 2·2k
R3 : 18 ohms
R4 : 2·2k
R5 : 2·2k
R6 : 4·7k
R7 : 4·7k
R8 : 1·5k
R9 : 100 ohms
R10 : 100 ohms
R11 : 100 ohms
C1 and C2 : 5uF 10v working electrolytic
VT1-VT4 : GE 2N2712
VT5, VT6 : T1 GC226A

connectors either end, at least one of which should be adjustable. It makes for easier adjustment if the adjustable clevis connector is outside the fuselage connecting with the horn on the control surface.

The trim bar which connects the elevator servo to the trim servo has its own adjustment which enables the degree of trim to be altered as required. The total trim movement is usually one fifth or one sixth of the full elevator movement.

Steerable nose wheels are connected to the rudder servo and the wire push rod is best arranged with some spring in it so that on landing, shocks taken by the nose wheel are not transmitted to the rudder servo. The push rod to the engine throttle control should also be flexible and the movement at the throttle lever should be slightly shorter than the movement at the servo so as to ensure that the throttle barrel is held hard up against the stop in both the fully open and fully closed positions.

Where space in the fuselage permits the receiver should always be mounted with its base in the vertical position and facing forwards, as this will reduce the possibility of crash damage. It is best wrapped in soft sponge rubber which should fit fairly tightly into the receiver compartment in the fuselage.

All wiring must be carried out with the greatest care. Soldered joints should be made only with the best quality cored solder and afterwards covered with p.v.c. sleeving. No wiring should be left loose but should be stitched down or glued down with Evo-Stik or some similar elastic adhesive. Switches should be of the highest quality with really positive contacts and the same applies to all plugs and sockets used. In fact it just is not possible to be too careful with your installation at any point.

RECEIVERS—

Receiver	*Matching Transmitter*	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*
Grundig 2 (Germany)	Grundig 2	Johannes Graupner, 7312 Kirchheim-Teck, Postfach 48, W. Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	Transistor super-regen, tuned filter, relay	2⅛ × 1½ × 1¼	2⅜
Metz 2 (Germany)	Metz 2	Metz Apparatewerke, Furth/Bayern, W. Germany	F. A. & F. Allen Ltd., 2 Dickens Lane, Poynton, Cheshire	Transistor super-regen relay, tuned filter	2·6 × 1·6 × 0·8	2½

RECEIVERS—

Telecont 3 (Germany)	Telecont 3	Reichert-Elektronik, Trier-Petrisberg, Box 743, W. Germany	Skol Kits, 166 Mile End Rd., London, E1	Transistor super-regen, relay, tuned filter	3 × 3 × 1¾	7
Metz 3 (Germany)	Metz 3	Metz Apparatewerke, Furth/Bayern, W. Germany	F. A. & F. Allen Ltd., 2 Dickens Lane, Poynton, Cheshire	Transistor super-regen, relay, tuned filter	2½ × 1½ × 1⅝	3½

RECEIVERS—

Grundig 4 (Germany)	Grundig 4	Johannes Graupner, 7312 Kirchheim-Teck, Postfach 48, W. Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	Transistor super-regen, relay, tuned filter	2⅛ × 1½ × 1⅞	3¾
Grundig 4 Superhet (Germany)	Grundig 4S	Johannes Graupner, 7312 Kirchheim-Teck, Postfach 48, W. Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	Transistor superhet, tuned filter, relay	2⅛ × 1½ × 2¾	5⅜
Kraft KR-4 (U.S.A.)	Kraft KT-4	Kraft Custom Radio Control 2519 Lee Avenue, South El Monte, Calif., U.S.A.	Regent Radio Models, 1 George St., Newcastle-under-Lyme, Staffs.	Transistor, superhet reed relayless	2⅞ × 1¾ × 1	3·4
Orbit 4 (U.S.A.)	Orbit 4	Orbit Electronics, 11612 Anabel Avenue, Garden Grove, Calif., U.S.A.	G. Franklin Radio Control, 101 Jarrom St., Leicester	Transistor superhet, reed relayless	3 × 2 × 1	3¾
R.E.P. Quadratone (British)	R.E.P. Quadratone	Derritron Radio Ltd., R.E.P. Division, Chapel Lane, High Wycombe, Bucks.	—	Transistor super-regen, reed, relay	3¼ × 1¾ × 2¼	6
Silvertone 4 (Australia)	Silvertone 4	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	Valve/ Transistor super-regen, reed, relay		

RECEIVERS—

Metz 5 Germany)	Metz 5	Metz Apparatewerke, Furth/Bayern, W. Germany	F. A. & F. Allen Ltd., 2 Dickens Lane, Poynton, Cheshire	Transistor super-regen, tuned filter, relay	2½ × 1½ × 1⅝ + 3½ × 1⅝ × ⅞	3½ + 2⅝

TWO CHANNEL

Voltage	*Batteries required*	*Current drain (mA)*		*Tone frequencies (c.p.s.)*	*Price*	*Other details*
		Idle	*Tone*			
6V	6V 225 DKZ DEAC	10		825, 1110	£21.19.0	Basic receiver with plug-in two channel filter unit. "Building-brick" assembly permits expansion to extra channels
6V	6V 225 DKZ DEAC Pack	15		2000, 3300		Completely wired unit

THREE CHANNEL

6V	6V 500 DKZ DEAC	5	25	5000, 6000, 7000	£22.15.0	Will accept plug-in filter units for expansion to extra channels
6V	6V 500 DKZ DEAC	Unknown		2280, 2730, 3300, 4250, 5100	£27.13.11	May be adapted to five channel by use of plug-in filter unit

FOUR CHANNEL

6V	6V 225 DKZ DEAC	10		800, 1110, 1700, 2325	£32.18.6	Plug-in filter units as per two channel unit. May be expanded up to 10 channels
6V	6V 225 DKZ DEAC	15		800, 1110, 1700, 2325	£53.19.0	"Building-brick" unit system as per Grundig super-regen Rx. No wiring required. Expandable to 10 channels
6V	6V 500 DKZ DEAC			370, 400, 480	$89.95 (U.S.A.) combined price Tx. + Rx.	Medco Reed Bank. Three I.F. stages
6V	6V 500 DKZ DEAC	20	65	370, 400, 440, 480	$65.00 (U.S.A.)	Medco Reed Bank. Servo wires braided into groupes to wire direct to servos (Bonner Transmite colour code)
9V	PP3	15	32	340, 360, 440, 460	£19.4.6	R.E.P. reed bank. R.E.P. relays
30V HT 1·5V LT	B123 2 × U7				£A42.5.0	

FIVE CHANNEL

6V	6V 500 DKZ DEAC			2280, 2730, 3300 4250, 5100	£27.13.11 + £12.3.8	Basic three channel unit with twin channel plug-in adaptor

RECEIVERS—

Receiver	*Matching Transmitter*	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*
Telecont 5 (Germany)	Telecont 5	Reichert-Elektronik, Trier-Petrisberg, Box 743, W. Germany	Skol Kits, 166 Mile End Rd., London, E1	Transistor super-regen, tuned filter, relay	3 × 2½ × 2½	7

RECEIVERS—

Citizenship RL-6 (U.S.A.)	Citizenship SL-6	Citizenship Radio Corp., 810 East 64th St., Indianapolis, Indiana, U.S.A.	Ripmax Ltd., Highgate Rd., London, NW5	Transistor superhet, reed, relayless	2⅞ × 1⅞ × 1	3⅓
Controlaire 6 (U.S.A.)	Controlaire 6	World Engines Inc., 8206 Blue Ash Rd., Cincinnati, Ohio, U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Transistor super-regen, reed, relayless	2 × 2 × 2	3
C. & S. 513 Wren (U.S.A.)	C. & S. 513 Hawk	C. & S. Distributors, 13400-12 Saticoy St., North Hollywood, Calif., U.S.A.	Roland Scott Ltd., 147 Derby St., Bolton, Lancs.	Transistor super-regen, reed, relayless	2⅛ × 1½ × 1	1⅞
Deans DM-60 (U.S.A.)	Deans DM-60	W. S. Deans Co., 8512 East Gardendale, Downey, Calif., U.S.A.	—	Valve/ Transistor super-regen, reed, relay	3⅛ × 1⅛ × 2⅛	5
Kraft KR-6 (U.S.A.)	Kraft KT-6	Kraft Custom Radio Control, 2519 Lee Ave., South El Monte, Calif., U.S.A.	Regent Radio Models, 1 George St., Newcastle-under-Lyme, Staffs.	Transistor superhet, reed, relayless	3 × 1¾ × 1	3·5
Min-X SH-6 (U.S.A.)	Min-X TT-6 Powermite	Min-X Radio Inc., 8714 Grand River Ave., Detroit, Mich., U.S.A.	Ed Johnson, Radio Control, Larkhill, Wilts.	Transistor, superhet, reed, relayless	3 × 2⅛ × 1	4
Orbit 6 (U.S.A.)	Orbit 6	Orbit Electronics, 11612 Anabel Ave., Garden Grove, Calif., U.S.A.	G. Franklin Radio Control, 101 Jarrom St., Leicester	Transistor superhet, reed, relayless	3 1/16 × 2 × 1	3¾
O.S.6 (Japan)	O.S.6	Ogawa Model Mfg. Co., Hiranababa, Higashisumiyoshi, Osaka, Japan	E. Keil & Co., Russel Gardens, Wick Lane, Wickford, Essex	Transistor, superhet, reed, relay		
R.C.S. Inter 6 (British)	R.C.S. Inter 6	Radio Control Specialists, National Works, Bath Rd., Hounslow, Middx.	—	Transistor super-regen, reed, relayless	3 × 1⅞ × 1	3
R.C.S. Inter 6 Superhet (British)	R.C.S. Inter 6	Radio Control Specialists, National Works, Bath Rd., Hounslow, Middx.	—	Transistor superhet, reed, relayless	3 × 1⅞ × 1	3¼
R.E.P. Sextone (British)	R.E.P. Sextone	Derritron Radio, R.E.P. Division, Chapel Lane, High Wycombe, Bucks.	—	Transistor, super-regen, reed, relay	3¼ × 1¾ × 2¼	7
Silvertone 6 (Australia)	Silvertone 6	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	Valve/ Transistor super-regen, relay		

FIVE CHANNEL (cont.)

Voltage	*Batteries required*	*Current drain (mA)*		*Tone frequencies (c.p.s.)*	*Price*	*Other details*
		Idle	*Tone*			
6V	6V 500 DKZ DEAC	5	25	4000–12,000	£34.14.0	Basic three channel unit with twin channel adaptor

SIX CHANNEL

Voltage	*Batteries required*	*Idle*	*Tone*	*Tone frequencies (c.p.s.)*	*Price*	*Other details*
9V	PP3	5	20	415, 470, 540, 555, 600, 665	£31.10.0	Citizenship reed bank. Three I.F. stages
4·8V	4·8V 500 DKZ DEAC	3	30–50		$45.00 (U.S.A.)	Supplied with 10 channel reed block. Only 6 reeds used
9V	PP9			370, 400, 440, 480, 540, 580	$42.50 (U.S.A.)	Medco reed bank
30V HT 1·5V LT	B123 2 × U7				$67.50 (U.S.A.)	Deans reed bank and relays. Relay wired ready to attach to servos
6V	6V 500 DKZ DEAC			370, 400, 440, 480, 540, 580	$74.95 (U.S.A.)	Medco reed bank. Three I.F. stages. Pre-cabled servo wires require only point-to-point wiring. Combo Tx./Rx. price £65.0.0
6V	6V 500 DKZ DEAC	8	55		£31.5.0	Min-X reed bank. Three I.F stages
6V	6V 500 DKZ DEAC	20	68	370, 400, 440, 480, 540, 580		Medco reed bank. Three I.F. stages. Pre-cabled, servo wires require only point-to-point wiring
					£57.2.0 Tx. and Rx. combo	O.S. reeds and relays
7·2V	7·2V 225 DKZ DEAC	3	35–50	380, 420, 460, 520, 560, 620	£14.0.0	Sold as complete unit with transmitter and ready wired servo, pack price £54.0.0
7·2V	7·2V 225 DKZ DEAC	5	40–50	380, 420, 460, 520, 560, 620	£25.10.0	Superhet version of basic super-regen "Inter 6" combo unit, with Tx. and servo pack
9V	PP9	15	32	340, 360, 440, 460, 480, 500	£23.7.3	
30V HT 1·5V LT	B123 HT 2 × U7 LT				£A46.10.0	

RECEIVERS—

Receiver	*Matching Transmitter*	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*
Grundig 8 (Germany)	Grundig 8	Johannes Graupner, 7312 Kirchheim-Teck, Postfach 48, W. Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	Transistor, super-regen, relay, tuned filter	2⅛ × 1½ × 3¼	6½
Grundig 8 Superhet (Germany)	Grundig 8S	Johannes Graupner, 7312 Kirchheim-Teck, Postfach 48, W. Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	Transistor superhet, tuned filter, relay	2⅛ × 1½ × 4 3/16	8⅛
R.E.P. Octone (British)	R.E.P. Octone	Derritron Radio, R.E.P. Division, Chapel Lane, High Wycombe, Bucks.	—	Transistor super-regen, reed, relay	3¼ × 1¾ × 2¼	8
Silvertone 8 (Australia)	Silvertone 8	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	Valve/ Transistor super-regen, reed, relay		

RECEIVERS—

Citizenship ZR-10 (U.S.A.)	Citizenship T.M.S	Citizenship Radio Corp., 810 East 64th St., Indianapolis, Indiana, U.S.A.	Ripmax Ltd., 86 Highgate Rd., London, NW5	Transistor superhet, reed, relayless	3¼ × 2⅛ × 1 1/16	4
Controlaire SH-20 (U.S.A.)	Controlaire MTT-10A	World Engines Inc., 8206 Blue Ash Rd., Cincinnati, Ohio, U.S.A.	Ed. Johnson Radio Control, Larkhill, Wilts	Transistor superhet, reed, relayless	2 1/16 × 1⅝ × 1 7/16	3¼
C.S. 508M Cardinal (U.S.A.)	C.S. 510 Eagle	C. & S. Distributors, 13400-12 Saticoy St., North Hollywood, Calif., U.S.A.	Roland Scott Ltd., 147 Derby St., Bolton, Lancs.	Transistor superhet, reed, relayless	3 × 1¾ × 1	3
Deans DM100 (U.S.A.)	Deans DM100	W. S. Deans Co., 8512 East Gardendale, Downey, Calif., U.S.A.	—	Transistor superhet, reed, relayless		
F. & M. Midas 10 (U.S.A.)	F. & M. Matador 10	F. & M. Electronics, 153 Vermont St., Albuquerque, N.M., U.S.A.	Southern Radio Controls, 1121b London, R., Norbury, London, SW16	Transistor superhet, reed, relayless	2⅞ × 2 × 1	4½
Grundig 10 (Germany)	Grundig 10	Johannes Graupner, 7312 Kirchheim-Teck, Postfach 48, W. Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	Transistor super-regen, tuned filter, relay	2⅛ × 1½ × 4¼	7⅞
Grundig 10 Superhet (Germany)	Grundig 10S	Johannes Graupner, 7312 Kirchheim-Teck, Postfach 48, W. Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	Transistor, superhet, tuned filter, relay	2⅛ × 1½ × 4⅞	7⅞
Kraft KR-10 (U.S.A.)	Kraft KT-10	Kraft Custom Radio Control, 2519 Lee Ave., South El Monte, Calif., U.S.A.	Regent Radio Models, 1 George St., Newcastle-under-Lyme, Staffs.	Transistor superhet, reed, relayless	3 × 1 × 1¾	3½
Metz 10 (Germany)	Metz 10	Metz Elektronik, Furth/Bayern, W. Germany	F. A. & F. Allen Ltd., 2 Dickens Lane, Poynton, Cheshire	Transistor superhet, tuned filter, relay	3½ × 2⅝ × 1¾ + 2⅝ × 1⅝ × 1½	8⅞ + 3½

EIGHT CHANNEL

Voltage	*Batteries required*	*Current drain (mA)*		*Tone frequencies (c.p.s.)*	*Price*	*Other details*
		Idle	*Tone*			
6V	6V 225 DKZ DEAC	5		825, 1110, 1700, 2325, 3000, 3670, 4300, 5700	£54.17.6	Basic receiver module into which are plugged four twin channel filter units in "Building-brick" manner
6V	6V 225 DKZ DEAC	15		825, 1110, 1700, 2325, 3000, 3670, 4300, 5700	£75.18.0	As above
9V	PP9	15	32	300–500	£27.9.6	
30V HT 1·5V LT	B123 HT 2×U7				£A50.10.0	

TEN CHANNEL

9V	PP9	6	68	350–675	£49.0.0	Deans reed bank
4·8V	4·8V 500 DKZ DEAC	5	40–500	340, 370, 400, 430 460, 490, 530, 570, 610, 650	$79.98 (ass.) $54.98 (kit)	Medco reed bank available in kit form or ready assembled
6V	6V 500 DKZ DEAC	13		340, 370, 400, 430, 460, 490, 530, 570, 610, 650	$79.50 (U.S.A.)	Medco reed bank. Transfilter I.F. stages
6V	6V 500 DKZ DEAC			350–675		Deans reed bank. Three I.F. stages
6V	6V 500 DKZ DEAC	11	38	340, 370, 400, 430, 460, 490, 530, 570, 610, 650	£38.10.0	Medco reed bank. Three I.F. stages. Pre-cabled servo wires
6V	6V 225 DKZ DEAC			825, 1110, 1700, 2325, 3000, 3670, 4300, 5700, 6370, 7150	£65.17.0	Basic receiver module with five plug-in twin channel filter units
6V	6V 225 DKZ DEAC			825, 1110, 1700, 2325, 3000, 3670, 4300, 5700, 6350, 7150	£86.17.6	As above
6V	6V 500 DKZ DEAC			340, 370, 400, 430, 460, 490, 530, 570, 610, 650	$79.95 (U.S.A.)	Medco reed bank. Three I.F. stages. British Tx./Rx. combo price £105.0.0
6V	6V 500 DKZ DEAC			2200–7900	£49.12.3 + £20.2.10	Six channel main Rx. unit with four channel plug-in unit. Servos plug-in—no wiring required

RECEIVERS—

Receiver	*Matching Transmitter*	*Manufacturer*	*British Importer (if Foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*
Min-X SH-10 (U.S.A.)	Min-X TT-10 Powermite	Min-X Radio, 8714 Grand River Ave., Detroit, Michigan, U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Transistor superhet, reed, relayless	2 15/16 × 2⅛ × 1	4
Oakfield 192/10R (British)	Oakfield 202M/10R	Oakfield Radio Ltd., Macclesfield Rd., Hazel Grove, Cheshire	—	Transistor superhet, reed, relayless	2½ × 2¼ × 1	3
Orbit 10 (U.S.A.)	Orbit 10	Orbit Electronics, 11612 Anabel Ave., Garden Grove, Calif., U.S.A.	G. Franklin Radio Control, 101 Jarrom St., Leicester	Transistor superhet, reed, relayless		
O.S.10 Minitron (Japan)	O.S.10 Minitron	Ogawa Model Mfg. Co., Hiranababa, Higashisumiyoshi, Osaka, Japan	E. Keil & Co. Ltd., Russel Gardens, Wick Lane, Wickford, Essex	Transistor superhet, reed, relayless	3 × 2¼ × 1	
R.C.S. Competition 10 (British)	R.C.S. Competition 10	Radio Control Specialists, National Works, Bath Rd., Hounslow, Middx.	—	Transistor superhet, reed, relayless	3 × 1⅞ × 1	3
R.C.S. Sports 10 (British)	R.C.S.10	Radio Control Specialists, National Works, Bath Rd., Hounslow, Middx.	—	Transistor super-regen, reed, relayless	3 × 1⅞ × 1	3
R.E.P. Decatone (British)	R.E.P. Decatone	Derritron Radio, R.E.P. Division, Chapel Lane, High Wycombe, Bucks.	—	Transistor, super-regen, reed, relayless	3¼ × 1¾ × 1⅛	3½
Silvertone 10 (Australia)	Silvertone 10	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	Valve/ Transistor super-regen, reed, relay		
Silvertone 2/10 (Australia)	Silvertone 10	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	Valve/ Transistor super-regen, reed, relayless	3 × 2⅛ × 1	
Silvertone 2/10 Superhet (Australia)	Silvertone 10	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	Transistor superhet, reed, relayless	2¾ × 1¾ × 1½	

RECEIVERS—

C.S. 508M Cardinal (U.S.A.)	C.S. 510 Eagle	C. & S. Distributors, 13400-12 Saticoy St., North Hollywood, Calif., U.S.A.	Roland Scott Ltd., 147 Derby St., Bolton, Lancs.	Transistor superhet, reed, relayless	3 × 1¾ × 1	3
Kraft KR-12 (U.S.A.)	Kraft KT-12	Kraft Custom Radio Control, 2519 Lee Ave., South El Monte, Calif., U.S.A.	Regent Radio Models, 1 George St., Newcastle-under-Lyme	Transistor superhet, reed, relayless	3 × 1¾ × 1	3½
F. & M. Midas 12 (U.S.A.)	F. & M. Matador 12	F. & M. Electronics, 153 Vermont St., Albuquerque, N.M., U.S.A.	Southern Radio Controls, 1121B London Rd., Norbury, London, SW16	Transistor superhet, reed, relayless	2⅞ × 2 × 1	4½

TEN CHANNEL (cont.)

Voltage	*Batteries required*	*Current drain (mA)*		*Tone frequencies (c.p.s.)*	*Price*	*Other details*
		Idle	*Tone*			
6V	6V 500 DKZ DEAC	6–10	50–55	340–640	£31.5.0	Min-X reed unit
9V	PP9	5		340–640		7·2V or 6V to order
6V	6V 500 DKZ DEAC			340, 370, 400, 430, 460, 490, 530, 570, 610, 650	$89.95 (U.S.A.)	Medco reed unit
					£95.10.0 Tx. and Rx. combo	O.S. reed unit
7·2V	7·2V 500 DKZ DEAC	5	40–50	350, 380, 410, 440, 470, 500, 530, 570, 610, 650	£26.0.0	R.C.S. reed unit. Four I.F. stages
7·2V	7·2V 500 DKZ DEAC	3	35–50	350, 380, 410, 440, 470, 500, 530, 570, 610, 650	£12.10.0	R.C.S. reed unit
9V	PP9	15	30–35	245, 275, 305, 335, 355, 380, 405, 435, 465, 500	£19.6.6	R.E.P. reed block
30V HT 1·5V LT	B123 HT 2×U7 LT			340, 370, 400, 430, 460, 490, 530, 570, 610, 650	£A54.16.0	Medco reed bank
30V HT 1·5V LT	B123 HT 2×U7 LT			340, 370, 400, 430, 460, 490, 530, 570, 610, 650	£A29.19.0	Medco reed unit
6V	6V 500 DKZ DEAC	3	25	340, 370, 400, 430, 460, 490, 530, 570, 610, 650	£A47.0.0	Medco reed unit

TWELVE CHANNEL

6V	6V 500 DKZ DEAC	13		310, 340, 370, 400, 430, 460, 490, 530, 570, 610, 650, 680	$89.50 (U.S.A.)	Medco reed unit. Transfilter I.F. stages
6V	6V 500 DKZ DEAC			310, 340, 370, 400, 430, 460, 490, 530, 570, 610, 650, 680	$89.95 (U.S.A.)	Medco reed bank
6V	6V 500 DKZ DEAC	11	28	310, 340, 370, 400, 430, 460, 490, 530, 570, 610, 650, 680	$98.50 (U.S.A.)	Medco reed unit

RECEIVERS—

Receiver	*Matching Transmitter*	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*
Min-X SH-12 (U.S.A.)	Min-X TT-12 Powermite	Min-X Radio, 8714 Grand River Ave., Detroit, Mich., U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	Transistor superhet, reed, relayless	$3 \times 2\frac{1}{8} \times 1$	4
Orbit 12 (U.S.A.)	Orbit 12	Orbit Electronics, 11612 Anabel Ave., Garden Grove, Calif., U.S.A.	G. Franklin Radio Control, 101 Jarrom St., Leicester	Transistor superhet, reed, relayless	$2\frac{7}{8} \times 2\frac{1}{8} \times 1$	5
O.S. 12 (Japan)	O.S. 12	Ogawa Model Mfg. Co., Hiranababa, Higashumiyoshi, Osaka, Japan	E. Keil & Co., Russel Gardens, Wick Lane, Wickford, Essex	Transistor superhet, reed, relayless	$3 \times 2\frac{3}{64} \times 1$	5
Remcon 2/12 Superhet (Kit) (British)	Remcon 12	Remcon Electronics, 4a The Broadway, Bexleyheath, Kent	—	Transistor superhet, reed, relayless	$2\frac{7}{8} \times 1\frac{7}{8} \times 1\frac{1}{4}$	

TRANSMITTERS—

Transmitter	*Matching Receiver*	*Manufacturer*	*British Importer (if foreign)*	*Size (in.)*	*Aerial (in.)*	*Wt. (oz.)*
Grundig 2 (Germany)	Grundig 2	Johannes Graupner, 7312 Kirchheim-Teck, Postfach 48, W. Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	$5\frac{5}{16} \times 3\frac{9}{16} \times 1\frac{3}{4}$	$57\frac{1}{2}$	$12\frac{1}{2}$ Less Batts.
Metz 2 (Germany)	Metz 2	Metz Apparatewerke, Furth/Bayern, W. Germany	F. A. & F. Allen, 2 Dickens Lane, Poynton, Cheshire	$5\frac{5}{16} \times 4\frac{1}{8} \times 2$		$22\frac{1}{2}$
Silvertone 2 (Australia)	Silvertone 2	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	$8 \times 8 \times 2\frac{3}{4}$		

TRANSMITTERS—

Metz 3 (Germany)	Metz 3	Metz Apparatewerke, Furth/Bayern, W. Germany	F. A. & F. Allen, 2 Dickens Lane, Poynton, Cheshire	$7\frac{5}{8} \times 5\frac{3}{4} \times 2$		$42\frac{1}{2}$
Telecont 3 (Germany)	Telecont 3	Reichert-Elecktronik, Trier-Petriberg, Box 743, W. Germany	Skol-Kits. 166 Mile End Rd., London, E1	$6\frac{1}{4} \times 3\frac{3}{4} \times 2$	49	

TRANSMITTERS—

Grundig 4 (Germany)	Grundig 4	Johannes Graupner, 7312 Kirchheim-Teck, Postfach 48, W. Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	$7\frac{7}{8} \times 5\frac{3}{4} \times 2\frac{3}{16}$	$49\frac{1}{4}$	$42\frac{1}{3}$ Less Batts.
Kraft 4 (U.S.A.)	Kraft	Kraft Custom Radio Control, 2519 Lee Avenue, South El Monte, Calif., U.S.A.	Regent Radio Models, 1 George St., Newcastle-under-Lyme, Staffs.	$6 \times 5 \times 3$	54	45

TWELVE CHANNEL (cont.)

Voltage	*Batteries required*	*Current drain (mA)*		*Tone frequencies (c.p.s.)*	*Price*	*Other details*
		Idle	*Tone*			
6V	6V 500 DKZ DEAC	6–10	50–55	340–640	£41.3.0	Min-X reed unit. Three I.F. stages
6V	6V 500 DKZ DEAC	4	50–58	310, 340, 370, 400, 430, 460, 490, 530, 570, 610, 650, 680	$99.95 (U.S.A.)	Medco reed bank. Three I.F. stages
						O.S. reed bank. Three I.F. stages
6V	6V 500 DKZ DEAC				£8.17.6 (Kit minus reed unit)	Three I.F. stages. Use reed bank with coil resistance of 40–90 ohms

TWO CHANNEL

Voltage	*Batteries required*	*Current drain (mA)*		*Tone frequencies (c.p.s.)*	*Price*	*Other details*
		Idle	*Tone*			
12V	2×6V 225 DKZ DEAC		45	825, 1110	£25.0.0	All transistor
3V	2×U2	50	400–800	2000, 3000		Valve/transistor circuitry. Power converter to feed valve
1·5V LT 135V HT	AD4 LT 2×B101 HT				£A35.10.0	Valve circuit. Hi-Lo power modes. Toriod stabilised audio oscillator. Convertible to 10 channels

THREE CHANNEL

6V	4×U2	60	400	2280, 2730, 3000	£23.9.8	Valve/transistor circuit. Power converter feeds valve. Convertible to 5 channels
12V	12V 225 DKZ DEAC	7	40	4000–7000	£39.12.0	All transistor

FOUR CHANNEL

12V	2×6V 1AH		95	825, 1110, 1700, 2350	£42.0.0	All transistor. Convertible to 8 channels
9V	PP9		60–70	370, 400, 440, 480	$89.95 with Rx. (U.S.A.)	All transistor

TRANSMITTERS—

Transmitter	*Matching Receiver*	*Manufacturer*	*British Importer (if foreign)*	*Size (in.)*	*Aerial (in.)*	*Wt. (oz.)*
Orbit 4 (U.S.A.)	Orbit 4	Orbit Electronics, 11612 Anabel Avenue, Garden Grove, Calif., U.S.A.	G. Franklin Radio Control, 101 Jarrom St., Leicester	6 5/16 × 6 × 3	47 Centre loaded	48½
R.E.P. Quadratone (British)	R.E.P. Quadratone	Derritron Radio, R.E.P. Division, Chapel Lane, High Wycombe, Bucks.	—	9½ × 6 × 3	48½	97
Silvertone 4 (Australia)	Silvertone 4	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	8 × 8 × 2¾		

TRANSMITTERS—

Metz 5 (Germany)	Metz 5	Metz Apparatewerke, Furth/Bayern, W. Germany	F. A. & F. Allen, 2 Dickens Lane, Poynton, Cheshire	7⅝ × 5¾ × 2 + 3⅝ × 1¾ × 1⅜		42½
Telecont 5 (Germany)	Telecont 5	Reichert-Electronik, Trier-Petrisberg, Box 743, W. Germany	Skol-Kits, 166 Mile End Rd., London, E1	6¼ × 3¾ × 2	49	

TRANSMITTERS—

Citizenship SL-6 (U.S.A.)	Citizenship RL-6	Citizenship Radio Corp., 810 East 64th St., Indianapolis, Indiana, U.S.A.	Ripmax Ltd., 86 Highgate Rd., London, NW5	6⅞ × 5⅝ × 2¾	Centre loaded	
C.S. 512 Hawk (U.S.A.)	C.S. 513 Wren	C. & S. Distributors, 13400-12 Saticoy St., North Hollywood, Calif., U.S.A.	Roland Scott Ltd., 147 Derby St., Bolton, Lancs.			
Controlaire 6 (U.S.A.)	Controlaire	World Engines Inc., 8206 Blue Ash Rd., Cincinnati, Ohio, U.S.A.	Ed. Johnson Radio Control, Larkhill, Wilts.	8 × 7 × 3¼	48 Centre loaded	56
Deans DM60	Deans DM60	W. S. Deans Co., 8519 East Gardendale, Downey, Calif., U.S.A.	—	9¾ × 6⅜ × 3⅛	54	
Kraft KT-6 (U.S.A.)	Kraft KR-6	Kraft Custom Radio Control, 2519 Lee Avenue, South El Monte, Calif., U.S.A.	Regent Radio Models, 1 George St., Newcastle-under-Lyme, Staffs.	6 × 5 × 3	54	46
Min-X TT-6 Powermite (U.S.A.)	Min-X SH-6	Min-X Radio, 8714 Grand River Ave., Detroit, Michigan, U.S.A.	Ed. Johnson Radio Control, Larkhill, Wilts.	7⅝ × ⅞ × 3⅛	24 Centre loaded	48
Orbit 6 (U.S.A.)	Orbit 6	Orbit Electronics, 11612 Anabel Ave., Garden Grove, Calif., U.S.A.	G. Franklin Radio Control, 101 Jarrom St., Leicester	6 5/16 × 6 × 3	47 Centre loaded	48
O.S. Minitron 6 (Japan)	O.S. Minitron 6	Ogawa Model Mfg., Co., Hiranababa, Higashisumiyoshi, Osaka, Japan	E. Keil & Co. Ltd., Russel Gardens, Wick Lane, Wickford, Essex			

FOUR CHANNEL (cont.)

Voltage	Batteries required	Current drain (mA)		Tone frequencies (c.p.s.)	Price	Other details
		Idle	Tone			
9V	PP9	42	35	370, 400, 440, 480	$69.00 (U.S.A.)	All transistor
1·5V LT 135V HT	AD4 LT 2×B101 HT	LT 250 HT 25	LT 250 HT 24	340, 360, 440, 460	£19.4.6.	Valve circuit
1·5V LT 135V HT	AD4 LT 2×B101 HT				£A38.15.0	Valve circuit. Convertible to 10 channels

FIVE CHANNEL

6V	4×U2	60	400	2280, 2730, 3000, 4250, 5100	£23.9.8 + £8.8.9	Three channel Tx. with plug-in adaptor unit. Valve/transistor circuit with power converter to feed valve
12V	12V 225 DKZ DEAC	7	40	4000–12,000	£46.14.0	All transistor

SIX CHANNEL

9V	PP9	41	39	470, 515, 540, 555, 600, 665	£42.10.0	All transistor
9V	PP9			370, 400, 440, 480, 540, 580	$64.50 (U.S.A.)	All transistor
9V	PP9		59		$69.98 (U.S.A.)	All transistor. May be converted to 10 channel bi-simultaneous unit
1·5V LT 135V HT	AD4 LT 2×B101 HT				$71.50 (U.S.A.)	Valve circuit
9V	PP9		60–70	370, 400, 440, 480, 540, 580	$69.95 (U.S.A.)	All transistor, bi-simultaneous. British Tx./Rx. combo price £65.0.0
9V	PP9	46	44	300, 360, 410, 455, 500, 550	£36.0.0	All transistor, bi-simultaneous. Convertible to 12 channels
9V	PP9	45	43	370, 400, 440, 480, 540, 580	$79.00 (U.S.A.)	All transistor
12V	2×PP1	42	35	335, 350, 389, 425, 475, 525	£24.0.0	All transistor. Non-simultaneous Not normally supplied, separately

TRANSMITTERS—

Transmitter	*Matching Receiver*	*Manufacturer*	*British Importer (if foreign)*	*Size (in.)*	*Aerial (in.)*	*Wt. (oz.)*
R.C.S. 6 (British)	R.C.S. Super-regen or superhet	Radio Control Specialists, National Works, Bath Rd., Hounslow, Middx.	—	5¼ × 3⅛ × 7	43 Centre loaded	52
R.E.P. Sextone (British)	R.E.P. Sextone	Derritron Radio, R.E.P. Division, Chapel Lane, High Wycombe, Bucks.	—	9½ × 6 × 3	48½	100
Silvertone 6 (Australia)	Silvertone 6	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	8 × 8 × 2¾		

TRANSMITTERS—

Grundig 8 (Germany)	Grundig 8 Super-regen or superhet	Johannes Graupner, 7312 Kirchheim-Teck, Postfach 48, W. Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	7⅞ × 5¾ × 2 3/16	49	45 Less batts.
R.E.P. Octone (British)	R.E.P. Octone	Derritron Radio, R.E.P. Division, Chapel Lane, High Wycombe, Bucks.	—	9½ × 6 × 3	48½	102
Silvertone 8 (Australia)	Silvertone 8	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	8 × 8 × 2¾		

TRANSMITTERS—

Citizenship TMS (U.S.A.)	Citizenship ZR-10	Citizenship Radio Corp., 810 East 64th St., Indianapolis, Indiana, U.S.A.	Ripmax Ltd., 86 Highgate Rd., London, NW5	8¼ × 6⅝ × 2¾	Centre loaded	
Controlaire MTT10A (U.S.A.)	Controlaire SH-20	World Engines, Inc., 8206 Blue Ash Rd., Cincinnati, Ohio, U.S.A.	Ed. Johnson, Radio Control, Larkhill, Wilts.	8 × 7 × 3¼	48 Centre loaded	56
C.S. 510 Eagle (U.S.A.)	C.S. 508 Cardinal	C. & S. Distributors, 13400-12 Saticoy St., North Hollywood, Calif., U.S.A.	Roland Scott Ltd., 147 Derby St., Bolton, Lancs.	7½ × 6 × 2⅞	55 Centre loaded	62
Deans DM 100 (U.S.A.)	Deans DM 100	W. S Deans Co., 8512 East Gardendale, Downey, Calif., U.S.A.	—	9¾ × 6⅜ × 3⅛		
F. & M. Matador 10 (U.S.A.)	F. & M. Midas 10	F. & M. Electronics Inc., 153 Vermont St., Albuquerque, N.M., U.S.A.	Southern Radio Controls, 1121B London Rd., Norbury, London, SW16	8⅛ × 6¼ × 2¾	58	52
Grundig 10 (Germany)	Grundig 10 Super-regen or superhet	Johannes Graupner, 7312 Kirchheim-Teck, Postfach 48, W. Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	7⅞ × 5¾ × 2 3/16	49	46 Less batts.
Kraft KT-10 (U.S.A.)	Kraft KR-10	Kraft Custom Radio Control, 2519 Lee Ave., South El Monte, Calif., U.S.A.	Regent Radio Models, 1 George St., Newcastle-under-Lyme, Staffs.	6¼ × 6 × 3	54	52

SIX CHANNEL (cont.)

Voltage	*Batteries required*	*Current drain (mA)*		*Tone frequencies (c.p.s.)*	*Price*	*Other details*
		Idle	*Tone*			
12V					£57.2.0 Tx. and Rx. combo	All transistor
1·5V LT 135V HT	AD4 LT 2×B101 HT	LT 250 HT 25	LT 250 HT 24	340, 360, 440, 460, 480, 500	£20.15.6	Valve circuit
1·5V LT 135V HT	AD4 LT 2×B101 HT				£A42.0.0	Valve circuit. Non-simultaneous. Convertible to 10 channel simultaneous

EIGHT CHANNEL

12V	2×6V 1AH		95	825, 1110, 1700, 2325, 3000, 3670, 4300, 5700	£50.0.0	All transistor. Bi-simultaneous
1·5V LT 135V HT	AD4 LT 2×B101 HT	LT 250 HT 25	LT 250 HT 24	300–500	£30.8.7	Valve circuit. Bi-simultaneous
1·5V LT 135V HT	AD4 LT 2×B101 HT				£A56.0.0	Valve circuit. Bi-simultaneous. Convertible to 10 channels

TEN CHANNEL

9V	PP9		55	360, 385, 425, 455, 470, 520, 560, 590, 620, 645, 680, 700	£69.0.0	All transistor. Bi-simultaneous
9V	PP9		52	340, 370, 400, 430, 460, 490, 530, 570, 610, 650	$99.98 (U.S.A.)	All transistor. Bi-simultaneous. Model UTT-10 with unmatched pots. $85.00
9V	PP9	80	75	340, 370, 400, 430, 460, 490	$109.50 (U.S.A.)	All transistor. Bi-simultaneous
1·5V LT 135V HT	AD4 LT ×B101 HT			360, 385, 425, 455, 470, 520, 560, 590, 645		Valve circuit. Bi-simultaneous
6V	Lantern Battery or 6V 1000 DKZ DEAC	125	180–250	340, 370, 400, 430, 460, 490, 530, 570, 610, 650	£48.10.0	All transistor. Bi-simultaneous
12V	2×6V 1AH		95	825, 1110, 1700, 2325, 3000, 3670 4300, 5700, 6350, 7150	£57.0.0	All transistor. Bi-simultaneous
9V	PP9			340, 380, 400, 430, 460, 490, 530, 570, 610, 850.	$119.50 (U.S.A.)	All transistor. Bi-simultaneous. British Tx./Rx. combo price £105.0.0

TRANSMITTERS—

Transmitter	*Matching Receiver*	*Manufacturer*	*British Importer (if foreign)*	*Size (in.)*	*Aerial (in.)*	*Wt. (oz.)*
Metz 10 (Germany)	Metz 10	Metz Apparatewerke, Furth/Bayern, W. Germany	F. A. & F. Allen, 2 Dickens Lane, Poynton, Cheshire	8¾ × 6½ × 2¾	48¾	59
Min-X TT-10 Powermite (U.S.A.)	Min-X SH-10	Min-X Radio Inc., 8714 Grand River Ave., Detroit, Michigan, U.S.A.	Ed. Johnson Radio Control, Larkhill, Wilts.	7⅝ × 7¼ × 3⅛	24 Centre loaded	48
Oakfield 202/M10R (British)	Oakfield 192/12R	Oakfield Radio Ltd., Macclesfield Rd., Hazel Grove, Cheshire	—	7¾ × 6 × 2¾	50	64
Orbit 10 (U.S.A.)	Orbit 10	Orbit Electronics, 11612 Anabel Avenue, Garden Grove, Calif., U.S.A.	G. Franklin Radio Control, 101 Jarrom St., Leicester	7¾ × 6½ × 3	47 Centre loaded	55
O.S. 10 Minitron (Japan)	O.S. 10 Minitron	Ogawa Model Mfg. Co., Hiranababa, Higashisumiyoshi, Osaka, Japan	E. Keil & Co. Ltd., Russel Gardens, Wick Lane, Wickford, Essex			
R.E.P. Decatone (British)	R.E.P. Decatone	Derritron Radio, R.E.P. Division, Chapel Lane, High Wycombe, Bucks.	—	9½ × 6 × 3	48	103
R.C.S. 10 (British)	R.C.S. Superhet or super-regen 10	Radio Control Specialists, National Works, Bath Rd., Hounslow, Middx.	—	7 × 5¼ × 3⅛	43 Centre loaded	52
Silvertone 10 Australia)	Silvertone 10	Silvertone Electronics, 727 Princes Highway, Tempe, N.S.W., Australia	—	8 × 8 × 2¾		

TRANSMITTERS—

C.S. 510 Eagle (U.S.A.)	C.S. 508 Cardinal	C. & S. Distributors, 13400-12 Saticoy St., North Nollywood, Calif., U.S.A.	Roland Scott Ltd., 147 Derby St., Bolton, Lancs.	7½ × 6 × 2⅞	55 Centre loaded	63
F. & M. Matador 12 (U.S.A.)	F. & M. Midas 12	F. & M. Electronics, 153 Vermont St., Albuquerque, N.M., U.S.A.	Southern Radio Controls, 1121B London Rd., Norbury, London, SW16	8⅛ × 6¼ × 2¾	58	53
Kraft KT-12 (U.S.A.)	Kraft KR-12	Kraft Custom Radio Control, 2519 Lee Ave., South El Monte, Calif., U.S.A.	Regent Radio Models, 1 George St., Newcastle-under-Lyme, Staffs.	6¼ × 6 × 3	54	53
Min-X TT-12 Powermite (U.S.A.)	Min-X SH-12	Min-X Radio Inc., 8714 Grand River Ave., Detroit, Michigan, U.S.A.	Ed. Johnson Radio Control, Larkhill, Wilts.	7⅝ × 7⅛ × 3¼	24 Centre loaded	48
Orbit 12 (U.S.A.)	Orbit 12	Orbit Electronics, 11612 Anabel Ave., Garden Grove, Calif., U.S.A.	G. Franklin Radio Control, 101 Jarrom St., Leicester	7¾ × 6¼ × 3	47 Centre loaded	56
O.S. 12 Minitron (Japan)	O.S. 12 Minitron	Ogawa Model Mfg., Co., Hiranababa, Higashisumiyoshi, Osaka, Japan	E. Keil & Co. Ltd., Russel Gardens, Wick Lane, Wickford, Essex		Centre loaded	

TEN CHANNEL (cont.)

Voltage	*Batteries required*	*Current drain (mA)*		*Tone frequencies (c.p.s.)*	*Price*	*Other details*
		Idle	*Tone*			
7·5V	5 × U2	150	280–300	2185, 2200, 3500, 4100, 4720, 5350, 6000, 6570, 7220, 7900	£53.7.5	Valve/transistor circuit. Power converter to valve circuit. Triple-simultaneous
9V	PP9		55	300–700	£44.0.0	All transistor. Bi-simultaneous. Convertible to 12 channels
18V	2 × PP9		35	300–700		All transistor. Bi-simultaneous
10V	10V 1·2AH Nickel cadmium pack	32	44	340, 370, 400, 430, 460, 490, 530, 570, 610, 650	$118.50 (U.S.A.)	All transistor. Bi-simultaneous
					£95.10.0 Tx. and Rx. combo	All transistor. Bi-simultaneous
1·5V LT 135V HT	AD4 LT 2 × B101 HT	250 LT 25 HT	250 LT 24 HT	280–500	£39.9.6	Valve circuit. Bi-simultaneous
12V	2 × PP1			350, 380, 410, 440, 470, 500, 530, 570, 610, 650	£42.0.0	All transistor. Bi-simultaneous
1·5V LT 135V HT	AD4 LT 2 × B101 HT			340, 370, 400, 430, 460, 490, 530, 570, 610 650	£A59.5.0	Valve circuit. Bi-simultaneous

TWELVE CHANNEL

9V	PP9	80	75	310, 340, 370, 400, 430, 460, 490, 530, 570, 610, 650, 680	$119.50 (U.S.A.)	All transistor. Bi-simultaneous
6V	Lantern battery or 100 DKZ DEAC	125	180–250	310, 340, 370, 400, 430, 460, 490, 530, 570, 610, 650, 680	$119.50 (U.S.A.)	All transistor. Bi-simultaneous
9V	PP9		60–70	310, 340, 370, 400, 430, 460, 490. 530, 570, 610, 650, 680	$129.95 (U.S.A.)	All transistor. Bi-simultaneous
9V	PP9		55	300–700	£48.0.0	All transistor. Bi-simultaneous
10V	10V 1·2AH Nickel cadmium pack	32	44	310, 340, 370, 400, 430, 460, 490, 530, 570, 610, 650	$133.50 (U.S.A.)	All transistor. Bi-simultaneous
12V						All transistor. Bi-simultaneous

TRANSMITTERS—

Transmitter	*Matching Receiver*	*Manufacturer*	*British Importer (if foreign)*	*Size (in.)*	*Aerial (in.)*	*Wt. (oz.)*
Remcon 12 (Kit) (British)	Remcon 12 Superhet	Remcon Electronics, 4a The Broadway, Bexleyheath, Kent	—	$7\frac{3}{4} \times 6\frac{5}{8} \times 2\frac{3}{8}$	Centre loaded	46

MULTI

Servo	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*	*Voltage*
Annco 2R (U.S.A.)	Annco Engineering Co., 7714 Colfax Avenue, South Minneapolis, Minnesota, U.S.A.	—	Relay, self neutralising or progressive	$1\frac{3}{4} \times 1\frac{9}{16} \times \frac{3}{4}$	1·3	4·8–6V
Annco 2RL	As above	—	Relayless, self neutralising or trim	$1\frac{3}{4} \times 1\frac{9}{16} \times \frac{3}{4}$	1·7	6V
Bonner Duramite (U.S.A.)	Bonner Specialities Inc., 9522 W. Jefferson Blvd., Culver City, Calif., U.S.A.	Various	Relay, self neutralising or progressive	$3\frac{3}{4} \times 1\frac{1}{2} \times 1$	$2\frac{1}{2}$	4·8–6V
Bonner Transmite	As above	Various	Relayless, self neutralising or progressive	$3\frac{3}{4} \times 1\frac{1}{2} \times 1$	3	6V
Citizenship TCB & TLB (U.S.A.)	Citizenship Radio Corp., 810 East 64th St., Indianapolis, Indiana, U.S.A.	Ripmax Ltd., 86 Highgate Rd., London, NW5	Relayless, self neutralising or progressive	$2\frac{5}{8} \times 1\frac{9}{16} \times 1$	$2\frac{3}{4}$	4·8–6V
C. & L. Servomite (British)	C. & L. Developments, 47 Queens Rd., Weybridge, Surrey	—	Relay, self neutralising or trim	$2 \times 1\frac{3}{4} \times 1\frac{1}{16}$	$1\frac{1}{2}$	4·8–6V
C. & L. Servomite Transistorised	As above	—	Relayless, self neutralising or trim	$2 \times 1\frac{3}{4} \times 1\frac{1}{16}$	$1\frac{3}{4}$	7·2–9V
C. & L. Servomite Pack	As above	—	Relayless	$6\frac{1}{2} \times 2\frac{3}{8} \times 1\frac{7}{8}$	$10\frac{1}{2}$ (10 chl.)	7·2–9V
Graupner Bellamatic 2 (Germany)	Johannes Graupner, 7312 Kirchheim-Teck, Postfach 48, W. Germany	Ripmax Ltd., 86 Highgate Rd., London, NW5	Relay, self neutralising	$1\frac{1}{2} \times 1\frac{1}{32} \times 1\frac{5}{16}$	$1\frac{1}{2}$	2·4V
Graupner Servo-automatic	As above	As above	Relay, progressive			2·4V
Graupner Trim-o-matic	As above	As above	Relay, progressive		1·2	
Metz 195/3 (Germany)	Metz Apparatewerke, Furth/Bayern, W. Germany	F. A. & F. Allen, 2 Dickens Lane, Poynton, Cheshire	Relay, self neutralising or progressive	$2\frac{1}{8} \times 1\frac{1}{2} \times \frac{13}{16}$	$1\frac{1}{2}$	6V

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* Throw and transit time details are quoted from neutral position where self neutralising and progressiv

TWELVE CHANNEL (cont.)

Voltage	*Batteries required*	*Current drain (mA)*		*Tone frequencies (c.p.s.)*	*Price*	*Other details*
		Idle	*Tone*			
12V	2 × PP1	50			£19.7.6 (Kit)	All transistor. Bi-simultaneous

SERVOS

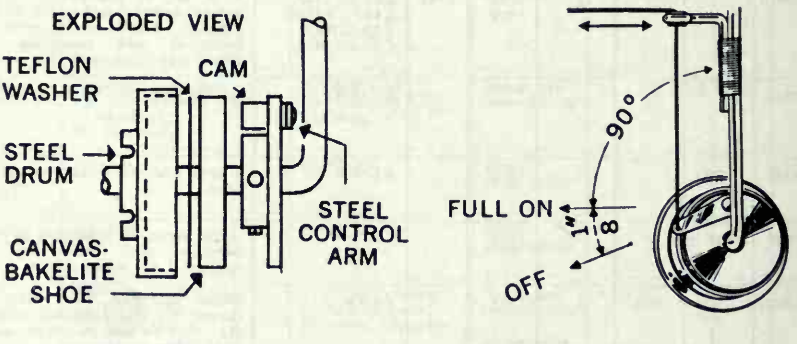
Motor	*Current drain (mA)*		*Throw* (in.)*	*Transit Time* (secs.)*	*Thrust (lb.)*	*Price*	*Other details*
	Transit	*Stall*					
Milliperm	320	370	$\frac{5}{16}$	$\frac{1}{2}$	2½	$7.95 (U.S.A.)	Transistor amplifier to convert servo to relayless operation $11.95
Milliperm	320	370	$\frac{5}{16}$	$\frac{1}{2}$	2½	$19.95 (U.S.A.)	Burn-out proof transistor circuitry
Bonner	250	750	$\frac{5}{16}$	0·4	4	£5.5.0	Metal case. Arc output drive
Bonner			$\frac{5}{16}$	0·4	4	S/N £11.10.0 Prog. £11.0.0	Self neutralising unit may be converted to trim by bending out wipers away from switcher plate
T.K.K.			$\frac{5}{16}$	0·35		TCB £14.10.0 TLB £14.10.0	May be converted to trim operation. Cam action on TCB gives slow start, fast finish to throw. TLB has linear action
Microperm			$\frac{1}{4}$		2–2½	£2.18.9	
Microperm		450–500	$\frac{1}{4}$	0·64–0·9	2–2½	£6.9.10	Available with aileron bellcrank and wing mounting bracket. S/N unit converts to trim
Microperm			$\frac{1}{4}$	0·64–0·9	2–2½	£37.3.9 (10) £43.13.7 (12) £23.12.6 (6) £30.2.0 (8)	6, 8, 10, 12 channel servo pack—4 servos mounted and wired to p.c. tray. Plug-in aileron servo with aileron bellcrank and mounting bracket. Multi way edge connector provided
Micromax						£6.15.0	Clutch override, spring centring
Micromax	30			0·9		£5.19.6	Clutch override to prevent stall at end stop
Micromax	150			0·9		£5.17.6	Trim servo for insertion in push rod between S/N servo and control surface. Lead screw action
Microperm	250–400	650	$\frac{1}{4}$	0·5		£5.8.0	When operated with Metz 10, is driven via transistorised amplifier in Rx. May be operated with one throw S/N, other progressive

versions are available. For throw and transit time figures for trim version, double figures quoted.

MULTI

Servo	*Manufacturer*	*British Importer (if foreign)*	*Type*	*Size (inches)*	*Wt. (oz.)*	*Voltage*
M.K. Multi (Japan)	Kato Model Co., 7 4-chome, Hattori-Monmachi, Toyonaka, Osaka, Japan	Henry J. Nicholls Ltd., 308 Holloway Rd., London, N7	Relay, self neutralising or progressive	2½ × 1¾ × 1¼	2¼	4·8–6V
M.K. Multi Relayless	As above	As above	Relayless, self neutralising and progressive	2½ × 1¾ × 1¼	2½	6V
R.C.S. Multi (British)	Radio Control Specialists, National Works, Bath Rd., Hounslow, Middx.	—	Relayless, self neutralising or progressive	2 × 1½ × ⅞	2	7·2V
Ripmax Maxamite (British)	Ripmax Ltd., 86 Highgate Rd., London, NW5	—	Relay, self neutralising or progressive	2 × 1¾ × ⅞	1½	4·8–7·2V
Ripmax Maxamite T	As above	—	Relayless, self neutralising or trim	2 × 1¾ × ⅞	1¾	6V
Rising Clutch Servo (British)	Rising & Schultz, Central Gardens, Whissendine, Nr. Oakham, Rutland	—	Relay, self neutralising			2·4–6V
Rising Progressive	As above	—	Relay, progressive			
Robbe Expert (Germany)	Robert Becker, 6421 Metzlos-Gehaag, (16), W. Germany	Skol-Kits, 166 Mile End Rd., London, E1	Relay, self neutralising or trim	2 × 1 7/16 × 15/16	2⅛	6V
Telecont R2 (Germany)	Reichert-Elektronik, Trier Petrisberg, Box 743, W. Germany	Skol-Kits, 166 Mile End Rd., London, E1	Relayless, self neutralising	2⅛ × 1⅜ × 1 3/16	2⅝	6V

* Throw and transit time details are quoted from neutral position where self neutralising and progressive

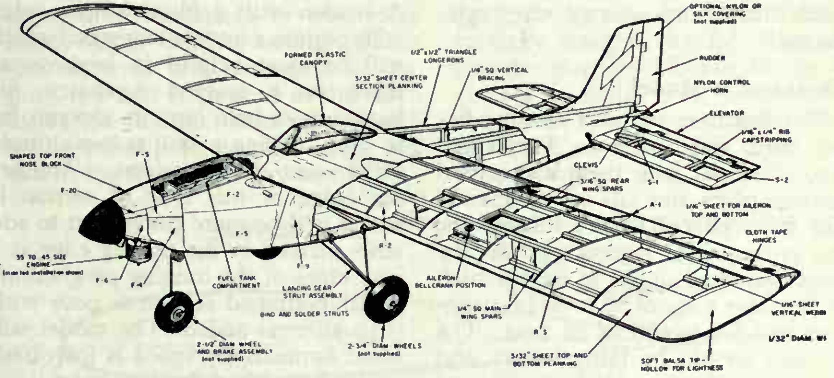


WHEEL BRAKE INSTALLATION DETAIL SHOWING DU-BRO BRAKE UNIT

SERVOS (cont.)

Motor	*Current drain (mA)*		*Throw* (in.)*	*Transit Time* (secs.)*	*Thrust (lb.)*	*Price*	*Other details*
	Transit	*Stall*					
							Rotary output
						S/N £8.18.6 Trim £8.8.6	Servo mounting tray with trim bar also available. Rotary output
Microperm	250	370	7/16	0·4	2½	£8.0.0	TASA amplifier with no centre tap
Milliperm	250	575	5/16	0·6	1½	£4.5.0	Mounts via shock absorbing rubber pad
Milliperm	250	575	5/16	0·6	1½	£9.19.6	As above. Single unit for trim or self neutralising
Mighty Midget	240–500		7/8	0·17–0·08	2–20	£3.8.1	Centrifugal clutch drive with spring centring
Mighty Midget						£2.19.6	Lead screw action. Slipping clutch prevents motor stall when drive shaft reaches maximum travel. Clutch pressure adjustable
	250		3/8		4	£5.8.0	
		400	½			£11.12.0	

versions are available. For throw and transit time figures for trim version, double figures quoted.


OPTIONAL NYLON OR SILK COVERING (not supplied)
RUDDER
NYLON CONTROL HORN
ELEVATOR
1/16" x 1/4" RIB CAPSTRIPPING
S-2
S-1
CLEVIS
3/16" SQ REAR WING SPARS
A-1
1/16" SHEET FOR AILERON TOP AND BOTTOM
CLOTH TAPE HINGES
1/16" SHEET VERTICAL WEBB
1/32" DIAM WI
SOFT BALSA TIP - HOLLOW FOR LIGHTNESS
5/32" SHEET TOP AND BOTTOM PLANKING
R-5
1/4" SQ MAIN WING SPARS
AILERON BELLCRANK POSITION
R-2
FORMED PLASTIC CANOPY
1/2" x 1/2" TRIANGLE LONGERONS
3/32" SHEET CENTER SECTION PLANKING
1/4" SQ VERTICAL BRACING
SHAPED TOP FRONT NOSE BLOCK
F-5
F-20
F-2
F-5
35 TO 45 SIZE ENGINE (inverted installation shown)
F-6
F-4
FUEL TANK COMPARTMENT
F-9
LANDING GEAR STRUT ASSEMBLY
BIND AND SOLDER STRUTS
2-1/2" DIAM WHEEL AND BRAKE ASSEMBLY (not supplied)
2-3/4" DIAM WHEELS (not supplied)

AIRFRAME DETAIL. JETCO CITATION MULTI R/C

INTRODUCTION TO MULTI CHANNEL R/C

BY
PETER WATERS

One of the most frightening moments of multi R/C, the first flight, depicted here as pilot at right prepares for his first attempt with a six channel A.P.S. Tauri. More experienced helper in centre has already checked out the model for correct trim.

A multi system is much more costly than single-channel due to the greater complexity of the equipment, both electronically and mechanically. In addition, the multi model is generally larger and requires a larger and more complex engine. It is therefore necessary to compare cost against possible effectiveness of multi to that obtainable from single-channel to appreciate that multi is well worth the expense. If you are in the process of changing from single, then you may well ask yourself why you wasted so much time and money on single-channel.

Choice of a Model

The beginner in multi-channel flying must start with a "Forgiving" type of model, and there are several suitable plans and kits on the market that have proved ideally suitable for this purpose. As a general guide, the novices' model ought to have a high or shoulder wing of 50 to 60 in. wingspan and 500 to 600 sq. in. area. The fuselage should be fairly roomy, and the construction should be conventional and sturdy.

A wingspan of between 50 and 60 in. and an area of 500 to 600 sq. in. has proved ideal. A smaller model will tend to have a high wing loading resulting in a fast glide with the risk of causing damage to the model and the gear inside it. A larger model is unnecessary, is more difficult to transport, requires a larger motor and costs more to build.

The airfoil section needs to be carefully chosen. Use 15% semi-symmetrical so that the model will not tend to zoom too much out of a turn. A section with a blunt leading edge will result in a low stalling speed which will be most helpful in landings as there is a marked tendency for beginners to hold onto up elevator far to long, risking a stall at low altitude which can be disastrous. Another advantage of this type of section is that it will be quite convenient to add strip ailerons to the trailing edge at a later stage of the training programme. A flat bottomed section is poor with strip ailerons added. The model will zoom immediately speed is increased, as in a turn when the nose drops.

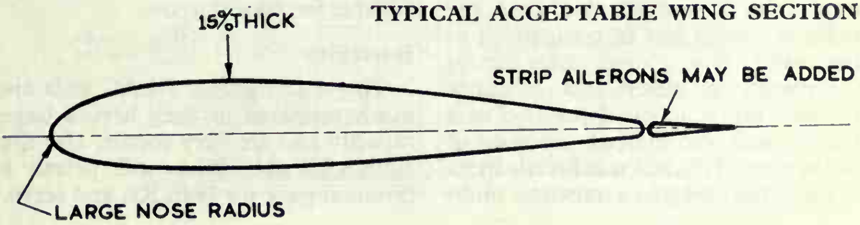
The size of the fuselage must be

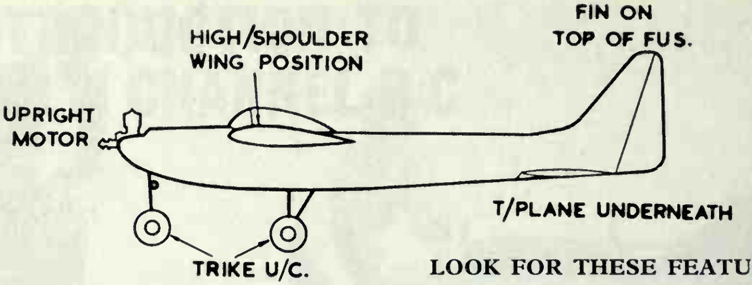
determined on the basis that the more room there is available the better. A box type construction is quite suitable, with a block top and bottom decking that can be rounded for a neat streamlined appearance. The tailplane is best mounted on the bottom of the fuselage because the fin can then be permanently placed on the top with no danger of trim changing. A fixed tailplane is preferred if possible, as it is easy for a removable one to move its position slightly and change the setting of the elevators. This has an apparent disadvantage of not being knock-offable in heavy landings, but as the elevators are connected to the push-rod that is secured to the servo inside the fuselage, then there would most probably be damage to the tail end of the fuselage in any case.

A tricycle undercarriage is recommended for easier take-offs, especially from short grass or tarmac. For long grass flying it does prove difficult to get a model off unless you use large diameter wheels and the conventional two wheeled layout. The tricycle type has an advantage being adaptable to steering quite easily and gives excellent ground handling.

A most popular and thoroughly recommended design that fills our requirements is the Tauri, available as a kit from Top Flite or A.P.S. plan. It has proved to be an excellent trainer specially designed by Ed. Kazmirski for the purpose of introducing beginners to multi. The Tauri can be fitted with four to ten-channel equipment and powered with 19 to 35 or even 49 cu. in. sized motors. For the

TYPICAL ACCEPTABLE WING SECTION





LOOK FOR THESE FEATURES

beginner it is recommended that a 19 be used with controls on rudder, elevator and optional engine. When this control system has been mastered the power can be stepped up to a 29 or 35 engine and trim elevators added. Finally, ailerons may be fitted. A further power increase to a 49 could be effected but this would be overpowering the airframe a little.

The Radio Equipment

This is the most expensive part of multi-flying and one has to be prepared to pay a lot for any reliable, well made set of equipment. It really is a truth to say that you pay for what you get, and for the utmost reliability, then the competition proved equipment is an obvious choice. However, it is well worth while considering the fact that a 12 channel outfit will not be in full use for a long time, perhaps a year, because it will take the average modeller this time to master and outfly the limitations of a six channel outfit.

The Transmitter

The hand held all transistor type transmitter is now standard, and the running cost is low in comparison to the valve type. Some transmitters incorporate a meter that indicates radiated power or on depression of a button, will also indicate the state of the battery. This is a worthwhile extra as the battery state in a transistor multi transmitter is as important as any other. The lever switches should be soft acting with no sharp edges, and a comfortable reach for the thumbs.

The Receiver

The choice here is between a superregen or superhet, and although it may seem advisable to have a superhet, a point to be considered is that these receivers are costly to repair. A superregen is cheaper, usually smaller in size and lighter. Relay receivers are now rarely used, and are big and heavy compared to the relayless type, which require special amplified servos.

Servos

The more popular ones are the Transmite or amplified Duramite. These are very powerful servos and withstand shock and vibration well. That's not to say that there are not others which give good service though. Some manufacturers advise the use of a particular servo with their gear, and it is advisable to use the recommended types. It is a very good idea to ask around the local R/C modellers what type they are using, and see if they are suitable for your purpose.

Batteries

The re-chargeable DEAC cells are much preferred as they have a large capacity and are very robust. Use the 500mA/H size which will permit a common pack for both Rx. and servo.

It is a good idea to install them more or less permanently, and charge them through a direct wired socket in the fuselage.

Installation

The glass-fibre servo tray is now popular enabling the servo to be transferred easily from model to model, and greatly simplifies wiring. In the case of independently mounted servos make a simple distributor board from a piece of printed circuit laminate and secure to one of the servos. Cover the wires with contact adhesive to prevent fractures.

Pack the Rx. in a foam rubber box with a small space around it to prevent vibration affecting the reeds. Do not tie the wires into a bunch, but secure the ends to the plugs by binding and covering with contact adhesive. Route the aerial out to the top of the fin securing with a thin rubber band and pack the batteries into their compartment with plenty of sponge around them.

Flying

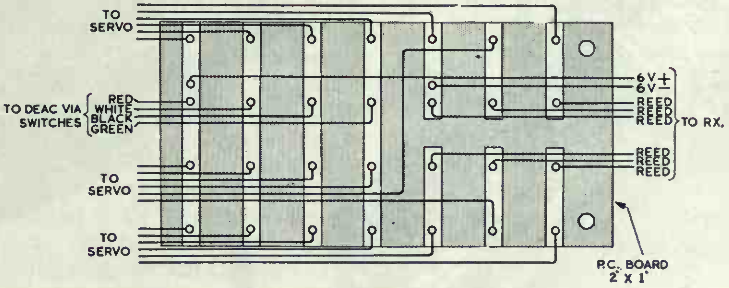
Remember that the golden rule of multi is *blip the levers,* not to hold them on. Leave the elevator control alone as much as possible. The reason for this is that novices tend to over-control the model, and excessive up elevator will easily stall the model. However, if you do get into difficulties, then hold up elevator and pray you have sufficient height to pull out. . . .

The first flight ought to be R.O.G. and assuming the model is reasonably built and the surfaces are at neutral, then attempt a take-off run at full throttle. Try a blip of up, after the model has gained speed, and if it is obviously not wanting to lift, then throttle down and try again with packing under the leading edge of the tail plane. This time the model ought to show signs of wanting to lift off, so increase the length of the blip of up elevator and keep blipping as the model climbs. On the other hand if the model zooms into the air almost as soon as you let her go, then packing is needed under the trailing edge of the tailplane. When making these adjustments re-check the neutral position of the surfaces, as this will alter a little. Any serious turning may be corrected with the rudder, for the moment, as we have to check the elevator trim both with full power and on idle for the glide.

When the motor is throttled down, carefully watch the model to see if it becomes under elevated. If this is so, then increase the elevator packing and add some downthrust to the motor to prevent it climbing too much on full power. The trim to aim for is a slight climb under full power and a flat glide.

In a similar manner trim out the turn so that the model flies straight with power on or off, by adjusting the side thrust.

DISTRIBUTOR BOARD



Turns are accomplished by gently blipping rudder followed by a few blips of up elevator to keep the nose high. Opposite rudder need not be given after turning, as the model will roll back to level flight provided the trim is correct. Wait until the model gains height from take-off before using rudder.

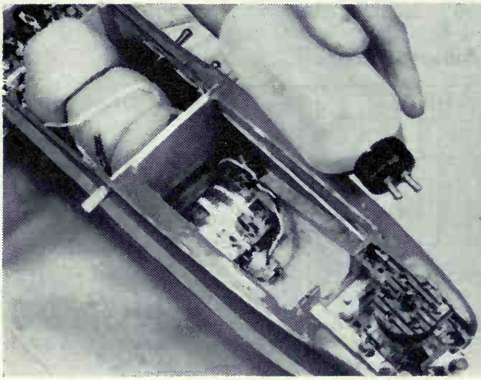
Fast turns can be accomplished by holding on rudder to give an almost vertical bank by the model, then holding up elevator to bring it around in a pylon turn. Try this out at first of course . . . remember that altitude is the best insurance!

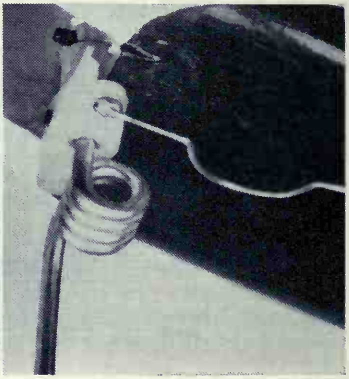
Ground manoeuvres are carried out on low throttle settings. Here you must watch that the ground speed is slow and be careful not to tip the model onto its nose when taxying down wind.

The landing seems to require a great deal of practice. The great trap is to hold the model off from touch-down for as long as possible, with a resulting stall. Fly the model fast at the ground, and give short blips of up elevator to flare the path out for a three pointer, when just about 2 ft. high.

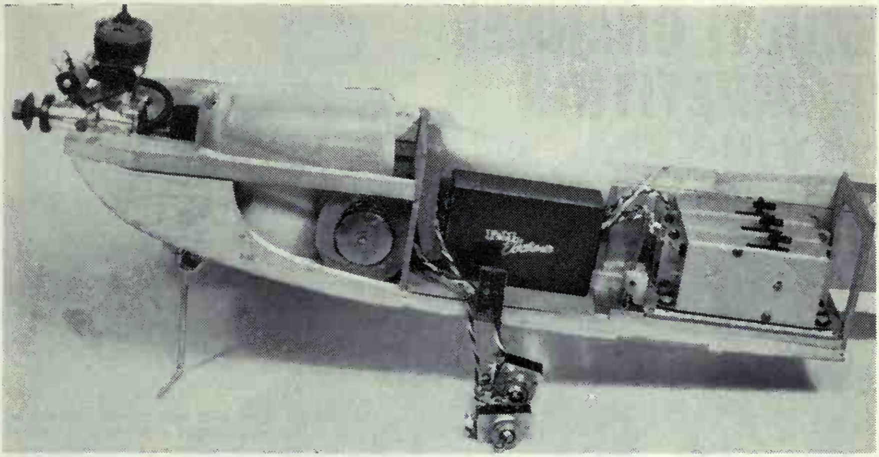
Pitfalls to Avoid

1. Do not use a low wing design, they are unstable.
2. Take great care in building model as warp free as possible. Fuel proof the engine and tank compartments thoroughly. This will pay dividends later when the model has aged. P.V.A. white glue is most suitable here, being fuel proof and easy to apply.
3. Avoid cheap radio equipment, as it will inevitably work out more expensive in the long run due to expensive repairs and might even result in a lost model.
4. Keep the batteries fully charged, and check the charging current on any charger that does not have a meter. It is a good rule to leave the DEAC's charging all night before you go flying. This will ensure that they are fully charged with no harm to them.
5. Use only good quality on/off switches; those with a knife action are considered most reliable. If possible, mount them on the side of the fuselage opposite the engine exhaust port.
6. Pack the receiver in a plastic bag to prevent fuel spray from





At left, the engine and tank bay of the Tauri, showing motor mounting, throttle cable run and battery placement. Below the steerable nosewheel detail showing loop in push rod to prevent crash load from reaching servo drive arm.



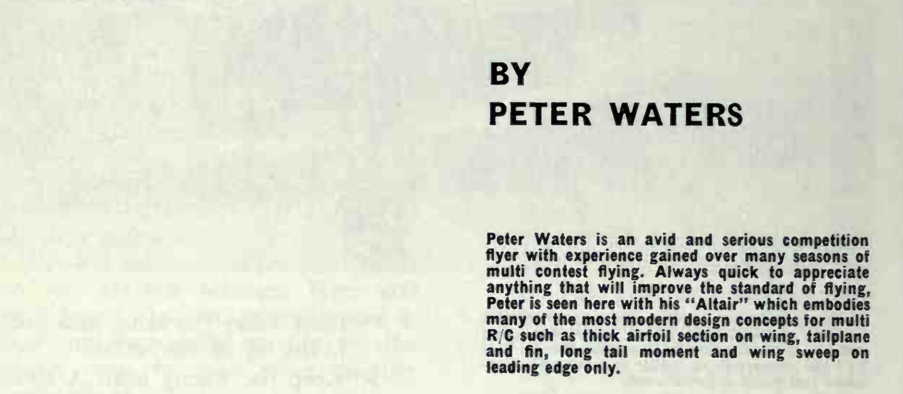
Tauri installation detail, showing respective positions of DEAC battery pack, superhet relayless receiver and three Bonner Transmite servos. Note "T" bar connection to rudder and steerable nosewheel just ahead of servo board.

affecting the reeds and components. It is advisable to stick thin strips of sponge under the wing seating to help seal this joint when the wing is in place.

7. Don't be frightened to use too many bands to hold the wings and tail units in position. Have enough tension on them to enable you to pick the model up by the wing tip without the fuselage being loose.
8. The fuel is most important, so keep it clean with filters in the filling tube. It is best to avoid a filter in the fuel line to the motor, as it will gradually block up and cause needle setting changes. It is far better to use a straight through pipe and filter the fuel into the tank when filling. A three pipe tank is recommended as this will leave the pick up tube on the motor all the while as you fill through one and block this off with a plug after the tank is filled. The third vents the tank, and goes to the top of the bottle.
9. Keep the wiring neat. A servo tray is a good idea. Try to keep the number of plugs and sockets to a minimum as these are often a source of trouble.
10. With a steerable tricycle undercarriage, the nose leg ought to be raked back slightly to give a small amount of castoring action and help prevent ground looping.
11. Do not have sloppy linkages, as they necessitate continual trim adjustments and can vibrate to cause loss of control in certain conditions. On the other hand, do not have stiff linkages, as they cause loss of servo power, and will lead to a damaged servo amplifier in extreme cases.
12. Do not fly too low, as things happen too quickly near the ground for beginners, and it is very dangerous.
13. File a notch onto the needle valve, as a reference for needle valve setting. An irregular setting usually indicates a dirty spray bar.

MULTI CHANNEL COMPETITION FLYING

BY PETER WATERS



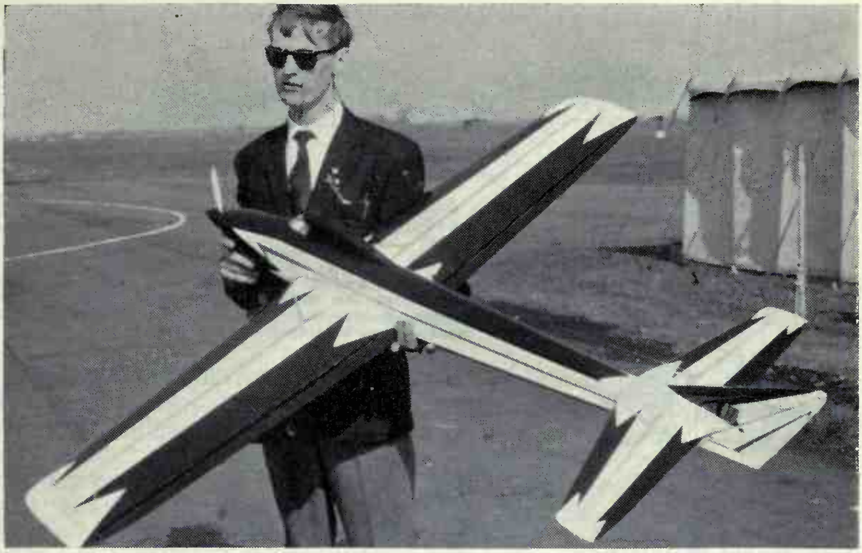
Peter Waters is an avid and serious competition flyer with experience gained over many seasons of multi contest flying. Always quick to appreciate anything that will improve the standard of flying, Peter is seen here with his "Altair" which embodies many of the most modern design concepts for multi R/C such as thick airfoil section on wing, tailplane and fin, long tail moment and wing sweep on leading edge only.

What makes the top competition flyers so good? Firstly, it must be their attitude towards the competition type of flying, as consistent results must come through careful preparation by a tidy mind. They are able to pay attention to small details, like the use of a certain type of propeller at all times so that the model's performance is constant, and these seemingly insignificant details all add up to make their performances that little bit better than others, so getting the extra points needed to win. Secondly, it must be something to do with the model, but the designs vary so much among the top pilots, that it is impossible to spot this exclusive detail. Finally, the radio gear used must be absolutely reliable, because to have faulty gear leads to broken models and disrupted flying training. It has often been said that a success in competitions is a result of 50% piloting skill, 25% model and 25% equipment. How far this is true, it is impossible to say, but it is a well known fact that the regular winners at competitions have to put in hours of flying in all weather conditions.

Choosing a Model

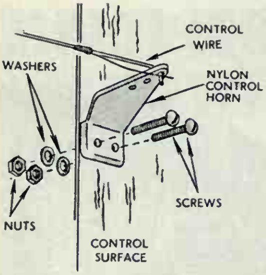
During the past few years, there has been a trend to use thicker sections on the wings, being as much as 22% of the wing chord. These models proved to be very smooth in flight, as the airfoil gives a lot of stability to the model on the pitch axis and smooths out the small jerks so noticeable with the thinner sectioned wings. In addition, the model performs more smoothly as the speed remains fairly constant in the manoeuvres, but one difficulty is that it needs extra up elevator to spin successfully, and extra power to do the upward roll. For smooth flying, 18% seems to be sufficient with a blunt nose on it so that the stalling speed is low.

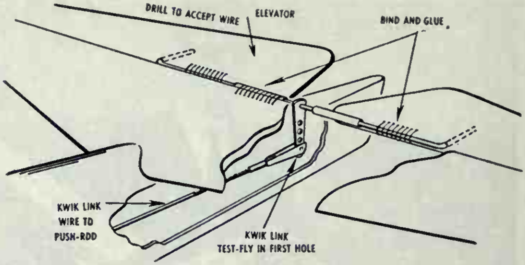
Strip ailerons are now common on most models, because they are easy to fit and maintain. However, you will find that the trim will change unless you make them out of good straight grained stock and as thick as you can.

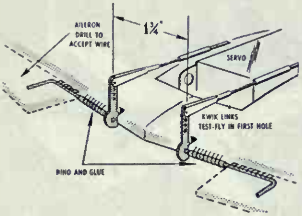


This will help to eliminate any warping tendancies, but as a further precaution always dope each side at the same time, not waiting for one side to dry before doing the other. The conventional method of securing the aileron horns to the strip type ailerons by pushing the ends of the wires into the edges of the ailerons and then covering with a piece of tape is not altogether successful. This is because in time the hole will enlarge and give rise to a certain amount of free movement in the assembly, but this trouble can be avoided if the hole is first made oversize, filled with epoxy adhesive and then the horn inserted. With the Taurus type wing construction, the ailerons pivot at their roots through brass tubes that are sewn onto the trailing edge of the centre section. The wing retention bands are pulled over these tubes, and in time the trailing edge is gently squashed in, with the result that the aileron trim is altered. This is a most frustrating fault, and can be avoided by reinforcing the trailing edge with a strip of hardwood, and the tubes then sewn and covered with epoxy adhesive.

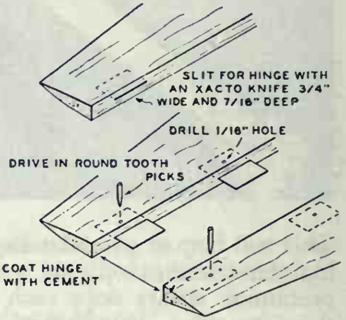
A tricycle under-carriage with a steerable nosewheel is almost universally used, and makes rise off ground much easier. However, the rigging of the model is important, and the conventional multi rigging of zero incidences on the wings and tailplane must be set up so that the wing is slightly negative to the ground. This will enable a smooth rise from the ground to be made with just a touch of up elevator to raise the wing for the necessary lift. If it is too negative, then the faster the model goes, the more firmly the model sticks to the ground, and a lot of up elevator is required to unstick. This will usually give a zooming climb, not what we need for contests. The slightly negative attitude is also useful for landings, because as soon as the main wheels touch down, the nose wheel will drop and then the negative incidence of the wing to the ground will hold the model on the deck.


CONTROL WIRE
WASHERS
NYLON CONTROL HORN
SCREWS
NUTS
CONTROL SURFACE


DRILL TO ACCEPT WIRE
ELEVATOR
BIND AND GLUE
KWIK LINK WIRE TO PUSH-ROD
KWIK LINK TEST-FLY IN FIRST HOLE


AILERON DRILL TO ACCEPT WIRE
1¾"
SERVO
KWIK LINKS TEST-FLY IN FIRST HOLE
BIND AND GLUE

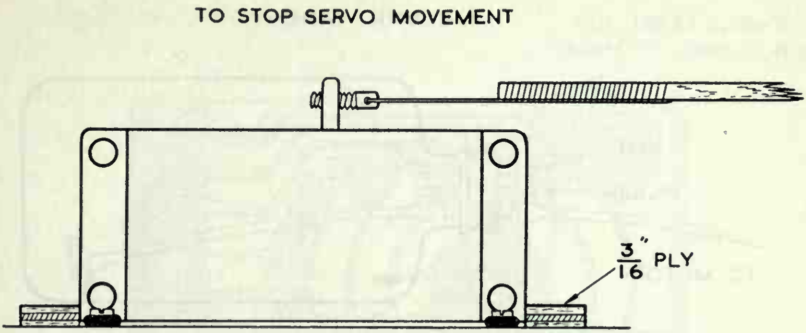
Control surface details. Top Left: Mounting of nylon type rudder horn. Above: One method of fitting elevator horn. Left: Installation of strip aileron horns. Below: Method of fitting mylar type control surface hinges.


SLIT FOR HINGE WITH AN XACTO KNIFE 3/4" WIDE AND 7/16" DEEP
DRILL 1/16" HOLE
DRIVE IN ROUND TOOTH PICKS
COAT HINGE WITH CEMENT

Equipment Installation

The actual method used for installing your equipment is not at all critical, provided care is used to ensure that all the items are secured so that they cannot move and yet give some degree of vibration damping. A servo tray is most useful, and are available for some servos on the market. These enable the fuselage mounted servos to be installed in one unit which helps the maintenance of the gear, and gives added rigidity to the fuselage. The wiring is much simpler, but in a crash the unit will manage to crush anything in front of it, usually the receiver! To avoid this, some modellers install their receivers behind the servos, but it is then more difficult as the push rods are in the way, and have to be disconnected to get at the receiver. The servos can be mounted onto the fuselage sides direct, but the retaining screws are then put through the fuselage sides being rather unsightly, and the wires need to be gathered to a distributor board. In this case they can be difficult to route. However, this is a light method of installation, and if weight is going to be critical, then it is the best solution. Whatever method is used, screw the servos down so that they cannot move their positions, and if necessary, cement ply pieces around them to stop any fore or aft movement.

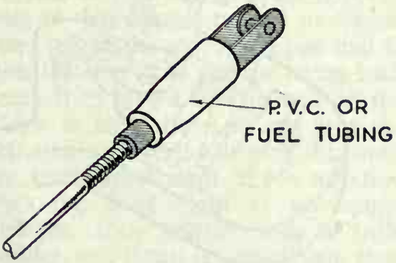
The push rods are neglected items that can create trouble unless made carefully. Firstly, use large section hard balsa of at least ⅜ in. square, and keep them as long as possible, ¼ in. square spruce is better but sand the corners off to enable them to slide easily over each other if they touch. Try to keep the wire ends in a straight line, as if they are cranked, then they can flex, and even give rise to flutter of the surfaces in a dive. Use adjustable clevises on the ends as these give a very fine degree of trim adjustment but slip a short length of sleeving over them to prevent them accidentally opening.



The receiver is mounted in plastic foam to give protection against vibration, and must have a small amount of space around it to help in doing this.

A clunk type of tank is universally used, and as bought might need a slightly heavier weight on the end of the flexible pick up feed. Check that this will fall all round the tank, even when held cap down, and that the length of the pick up tube is correct. Some of these pick up tubes expand when soaked in fuel so guard against this. A consistant idle on the motor is most important, and if the tank is installed with a thin layer of foam around it, this will help. Once the tank is in its place, leave it there for as long as you can because every time it is removed, there is a chance that small foreign particles can enter and cause partial blockages until they are cleared.

The batteries are also more or less permanently installed, as they are then out of the way, and are charged through a miniature plug and socket wired direct to the end terminal.



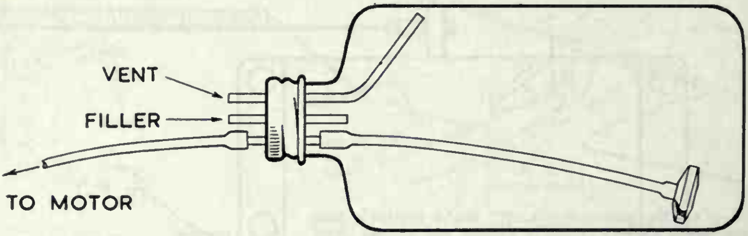
Trimming

The ideal trim to aim for will be:
(1) Straight and level flight, upright and inverted;
(2) Equally sized loops and bunts;
(3) No "screwing" of the loops and bunts;
(4) Equal rates of roll;
(5) Good ROG and landings;
(6) Ability to spin every time.

Before starting to trim, it must be emphasised again that the model must be built accurately, because with wing warps, wrong incidences, incorrect C.G., etc., it will be extremely difficult to arrive at a suitable trim.

After the usual first few flights when the model is roughly sorted out to give a reasonable straight flight, we must concentrate on getting the elevator trim correct. This means that there must be no elevator deflection to give level flight, and to check this, use trim elevator to get the model flying straight and level upright then land it without altering this trim setting. Do this with about half a tank of fuel so that the trim will be for the average fuel load. If, on checking, you find that it was necessary to have some down trim in for level flight, then you must pack the wing down at the leading edge to give less lift, but if you have up trim

CLUNK TANK



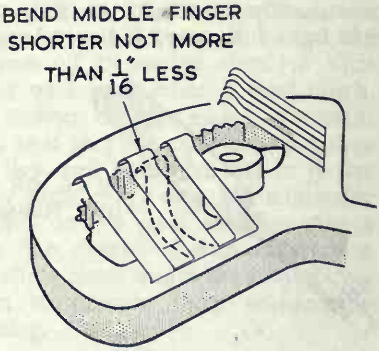
in, then increase the wing incidence. Repeat this procedure until you have neutral elevators for level flight, then cement the packing permanently in place. Next, we sort out the inverted trim. This manoeuvre comes into the schedule about half way through, so we check this one with a half full tank. Roll the model inverted and put in full down trim. You must adjust the amount of down trim so that at full travel, the servo will give sufficient deflection to cause a slight inverted climb. This means that we can now roll the model inverted and put in full down trim and find that the model is practically trimmed for this manoeuvre with no need to struggle to find the correct setting. The slight extra is useful for holding the nose up when doing inverted turns without the need of too much down elevator blipping. Excessive up trim is no problem and can be most useful for positive spins.

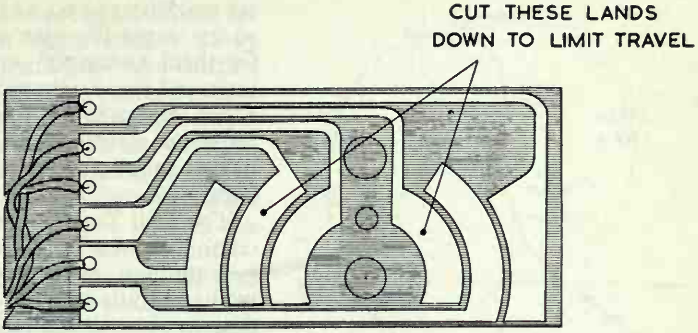
If you find it difficult to get the ideal setting of the trim servo for level flight, then slow the servo down with a suitable low ohm resistor in series with the motor lead.

The take-off will now be easy, as you simply feed in up trim to lift off, and for the landings as soon as the throttle is retarded, feed in full up trim to give the elevator setting for a steady approach. However, you might be in the happy position of having too much up elevator trim, and here it is advised to either alter the trim bar setting, or alter the servo travel by cutting the Printed Circuit Board.

The spin is a problem and with the thick sectioned designs, it is advised to use a servo overdrive board in the Transmite servo. This extra travel is switched in on low throttle either by means of a small micro switch, or a special switching board in the motor servo.

It is sometimes a headache to sort out the loops and bunts so that they are equal in diameter. In a case like this, a differential elevator horn can be used, but never seems the answer, as it inevitably means that you still require more down elevator to tighten the bunt to the size of the loop. If you are lazy, then it is a simple case of going into the eights with down trim in, which will





increase the loop diameter, and decrease the bunt diameter, not a very expert way of doing it. In order to get more down elevator, you can limit the up elevator movement by cutting the printed circuit board, and move the push rod in a hole in the elevator horn. However, the extra up elevator is needed for a positive spring, so we have to find another way. It is possible to increase the movement of a Bonner Transmite by carefully bending the middle contact fingers on the sector gear, and although this means stripping the servo down each time an adjustment is needed, it is by far the best method.

The trueness of the loops and bunts are next adjusted, and it is usually best to start with bunts. Turn the model downwing overhead and apply full down elevator. Watch carefully which way it screws, and note which aileron is needed to level it out at the finish of the bunt. After landing, adjust the ailerons so that they give the opposite bias to that control needed to correct the bunt at the top, *i.e.* if you had to give left aileron to put the wings back level, then give a turn or two on the clevis to raise the right and drop the left ailerons. Keep adjusting this until the bunts are straight. If you now find that the level flight is no longer straight, then correct with a little rudder, and if this is not enough, then you might find that one wing is heavier than the other.

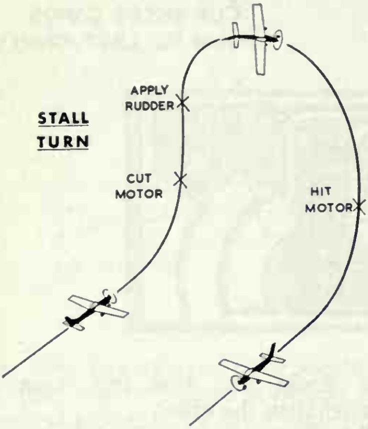
Equal rate of roll is a simple case of adjusting the amount of throw on the aileron horns. It is possible to get special over travel boards for Bonner Transmites that will give extra travel each way, or you can bend both the middle contact fingers to get the same result. This is to be preferred, as then you have a much more accurate linkage with less possible slop to cause trim changes.

Most engines are bolted onto bearers that have a predetermined amount of sidethrust for the design, but if you find that when the power is shut down the model turns off one way, then the side thrust is wrong, and if possible it ought to be adjusted, so that the model flies straight under all motor power conditions.

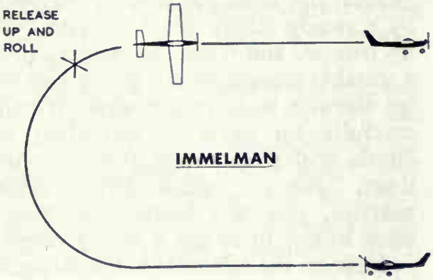
The Schedule

R.O.G. This must be a smooth gradual rise from the ground followed by a steady climb. Start off with full up trim in, and when the model gains a suitable ground speed, give a blip of up elevator to raise the nose. Watch carefully for signs of too sharp a climb, and if necessary put in some down trim in quick blips. With practice, you will know how many blips to put in to get a steady climb.

Next on the schedule is the straight



flight into wind, and for 10 seconds. After climbing to a suitable height, turn down wind and sort out elevator trim to give a slight under elevation on the down wind leg. When you turn into the wind for the straight flight passing over the Tx., you will then have only to alter a slight amount of the trim. Watch for any climb or dive, and correct with short blips of up elevator, then followed by a touch of trim. If the wing is dropping, then correct with short fast blips which won't be so noticeable as just one long one. The Procedure Turns are accomplished with the ailerons and elevators, but a much smoother turn is made by putting in some up trim before the turns and taking it off as soon as they are completed. The return flight is down wind and must be at the same altitude as the upwing leg. The judges are marking you on what they can see, so try to get the pattern high enough for them to see the whole procedure turn, and this height will also hide any slight deviation in the altitude, because the reference height of the skyline is much further away from the flight path.



The Stall Turn consists of a vertical climb followed by a cut in power, a turn through 180 degrees and a descent to the altitude of entry level with the descent patch parallel to the climb, and close to it. This seems to be best performed into the wind, but not too far away, as then it is difficult to see if the climb is vertical. Rudder needs to be applied at the top before the model slows down too much, and pick up the motor on the down leg.

The Immelman Turn is again best entred into the wind, as then the model will be moving all the while, whereas from a downwind entry there appears to be a pause at the top before rolling. It might be necessary to release up elevator before the half loop is completed, and sometimes a touch of down will help to stop the nose dropping in the roll, in any case up elevator is required after the roll to keep it level and on the same heading. If this is put in too early, then the exit heading will not coincide with the entry.

Three Consecutive, Concentric Loops are next, and these are best done into wind without too much pulsing. In the event of excessive drift due to strong wind it is better to hold on the signal and recover the lost ground between loops, than to pulse and have them ragged. With practice, you will find that if you release up after about 270 degrees of the loop is completed, the model will arrive back at the starting point, this is most important in windy conditions. Correct any screwing due to the wind with the rudder, as ailerons drastically alter the axis.

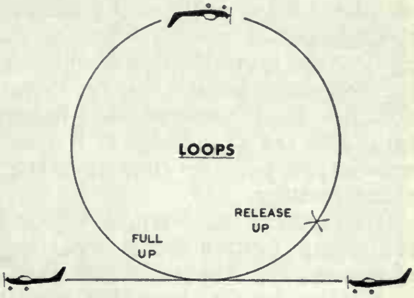
The three Consecutive Bunts are executed down wind, and in windy conditions, you will find them drifting in this direction unless you are able to fly back to the starting position at the bottoms by pulsing down elevator. There ought to be no need to correct screwing if the trimming was correct but if there is, then do it with the ailerons at the bottom of the bunt.

Reversals are best carried out into the wind, but put in a little down trim to stop a zoom on the recovery to level flight.

The Rolls are required to be on the same axis and immediately following each other. If they are done downwind, then they become stretched and look much better than if executed into the wind. Apply a blip of up before commencing the fall to lift the nose slightly, then nearly half way through, put in a touch of down to lift the nose when it is inverted. Do not overdo this as the tail will kick.

The Tail-Slide. This is a matter of luck, and seems to be best carried out from a Reversal to build up extra speed downwind. Quickly slow the motor, level the wings and signal up elevator for the vertical climb. If you see a wing dropping, then correct with rudder before the model stops. If all is correct, then the model will slide backwards. Pull out with up elevator and open the throttle.

In the case of a Horizontal Eight, the direction of entry for best results is a debatable point. The majority seem to prefer an into wind entry. The loop is followed by a bunt and the intersections must be vertical, which makes the change from up to down elevator signals a matter of critical timing, wrongly timed, then the two are not symmetrical.

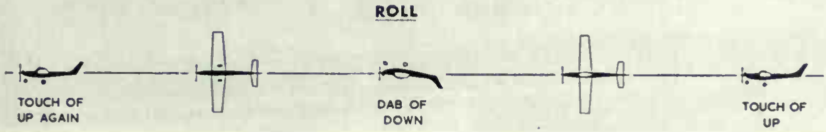


The Cuban Eight has two intersecting half rolls, which ought to be at right angles to each other. Perform this into the wind and on the second loop release up elevator early so as to stretch it back to the first one.

The Vertical Eight is relatively easy as you simply watch where the loop started and then fly back to this point for the bunt. It is important that the completion of the bunt intersects the entry of the loop which might necessitate releasing down to allow the model to climb a little, before leaving off.

During the trimming, you ought to have adjusted the amount of down trim so that all that is needed for straight inverted flight is to half roll and apply full down trim. This will give a slight inverted climb, and a few blips of up trim will soon cure it. Start the 10 seconds downwind and away from you, so that the judges will be able to see if the elevation is steady or not, and the model will not get too far away from you by the end.

Put in some down trim for the Overhead Inverted Eight. This will



help keep the nose up, and make the turns smoother as less blips of up elevator are needed. After completing the first circle, be sure that the model does not climb into the wind before turning it the other way. It is often necessary to pulse up elevator to stop this happening.

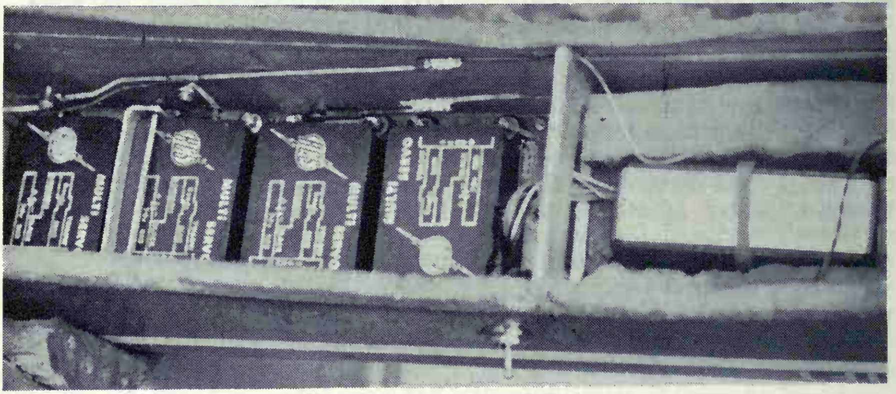
To perform the Vertical Upward Roll satisfactorily a model needs lots of power and a fast rate of roll. From a medium height, bank the model around into a descending turn, level off into wind and before the speed drops off, pull up into a vertical climb and immediately apply full aileron. As soon as the roll is complete, put in down elevator to level the model onto the same heading as it started.

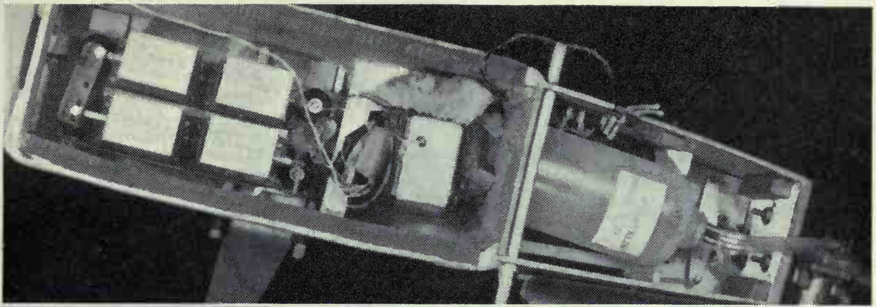
Most models seem to spin better one way more than the other, and obviously the more positive direction is the one to use. Gain height and throttle the motor. Now pulse in up elevator increasing the length of the pulses until the model stops its forward speed, then apply up elevator and rudder to spin. Three complete turns are required, and most models will carry on for a turn or two before pulling out, so time the release of signals to give three turns. Pull out into the same heading as the entry.

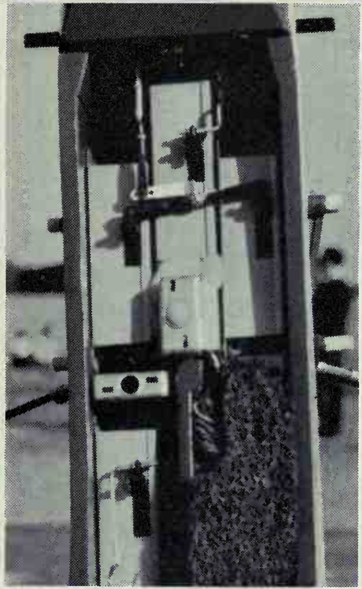
The Landing Pattern, consists of a descending rectangular pattern, so commence it high enough to make the steady descent on each leg noticeable. Retard the throttle gradually during the pattern, and put in a little up trim to make up for the loss of power. Make the final leg straight up to the landing circles, with full low speed throttle for flare-out and touchdown. If you are certain that the model is going to undershoot, then increase the motor idle to stretch the approach. If you are overshooting, then get down by putting in some down trim, and flare out at the spot.

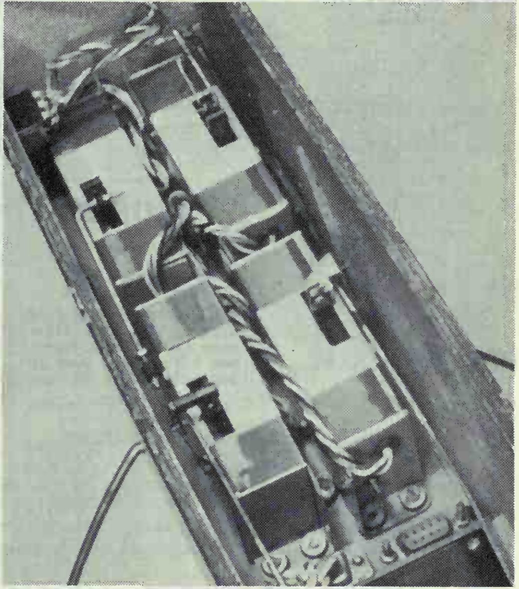
One final word about the motor. This seems to be extremely important in successful competition, and needs to be treated with respect. The tank and fuel must be spotlessly clean, and the idle setting must be reliable. Some modellers have even found it necessary to use two channels for changing the needle setting in flight, and this might be advisable if you have difficulty setting the needle on your motor correctly.

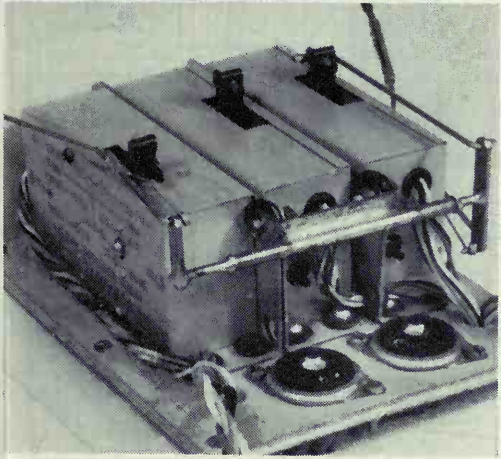
Equipment installation details. Below: R.C.S. servos and 10 channel superhet Rx. Opposite Top: Equipment and tank bays of a DeBolt Jenny, showing C. & L. Servopack, Rx., tank and steerable nosewheel link. Second Left: 10 channel installation using Bonner servos is a tight fit in a Tauri. Second Right: 10 channel installation using Bonner servos. Front of compartment at top. Rx. mounted at rear to minimise crash damage. Bottom Left: Six channel servo installation board with coupled aileron/rudder linkage. Bottom Right: Aileron servo installation with strip ailerons.

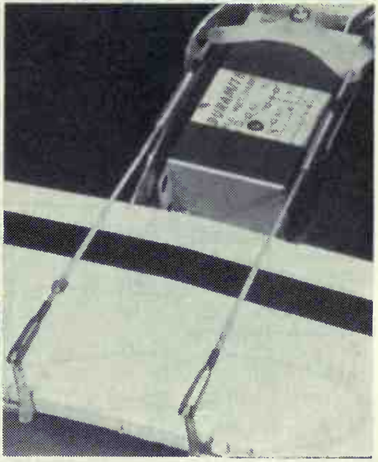


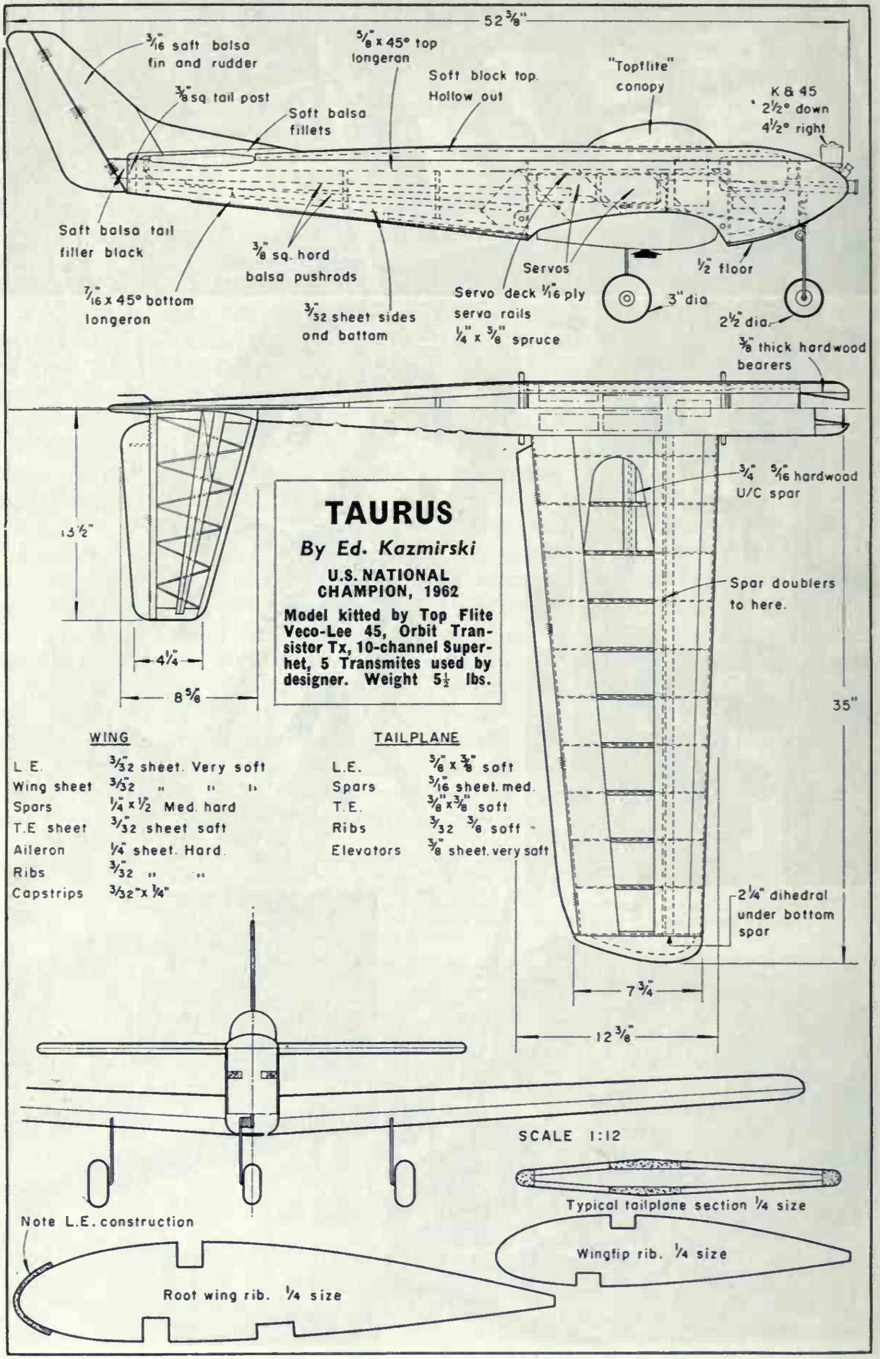











52 3/8"
3/16" soft balsa fin and rudder
3/8" sq tail post
5/8" x 45° top longeron
Soft balsa fillets
Soft block top. Hollow out
"Topflite" canopy
K & 45
2½° down
4½° right
Soft balsa tail filler block
3/8" sq. hard balsa pushrods
7/16" x 45° bottom longeron
3/32" sheet sides and bottom
Servos
Servo deck 1/16" ply
servo rails
1/4" x 3/8" spruce
3" dia
1/2" floor
2½" dia.
3/8" thick hardwood bearers
3/4" 5/16" hardwood U/C spar
Spar doublers to here.
13½"
4¼
8 5/8
35"
2¼" dihedral under bottom spar
7 3/4"
12 3/8"
SCALE 1:12
Typical tailplane section ¼ size
Wingtip rib. ¼ size
Note L.E. construction
Root wing rib. ¼ size

TAURUS

By Ed. Kazmirski

U.S. NATIONAL CHAMPION, 1962

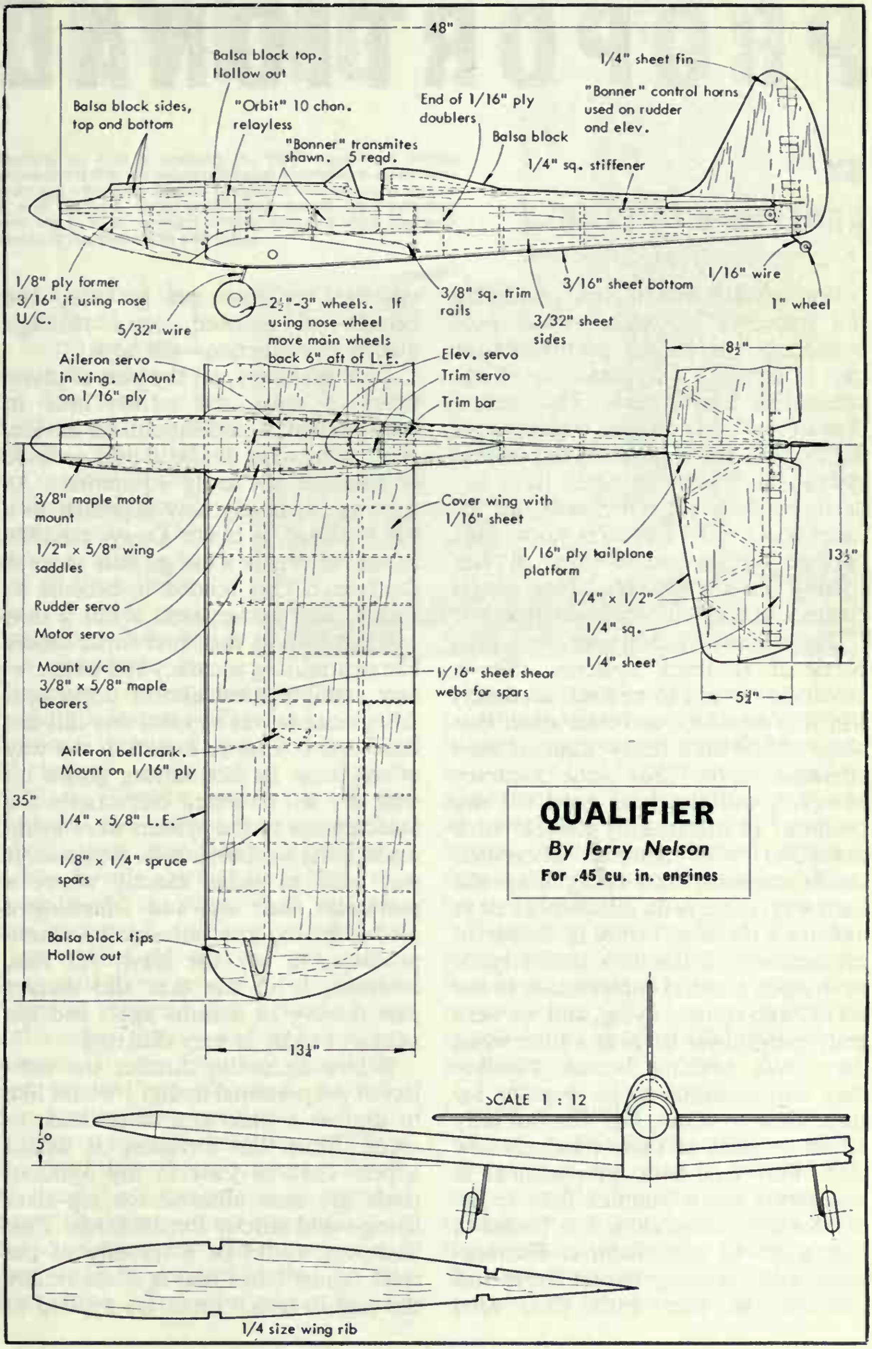
Model kitted by Top Flite Veco-Lee 45, Orbit Transistor Tx, 10-channel Superhet, 5 Transmites used by designer. Weight 5½ lbs.

WING

L.E.	3/32" sheet. Very soft
Wing sheet	3/32" " " "
Spars	1/4" x 1/2" Med. hard
T.E sheet	3/32" sheet soft
Aileron	1/4" sheet. Hard.
Ribs	3/32" " "
Capstrips	3/32" x 1/4"

TAILPLANE

L.E.	5/8" x 3/8" soft
Spars	5/16" sheet. med.
T.E.	3/8" x 3/8" soft
Ribs	3/32 3/8 soft
Elevators	3/8" sheet. very soft



QUALIFIER

By Jerry Nelson

For .45 cu. in. engines

48"
Balsa block top. Hollow out
Balsa block sides, top and bottom
"Orbit" 10 chan. relayless
"Bonner" transmites shown. 5 reqd.
End of 1/16" ply doublers
Balsa block
1/4" sheet fin
"Bonner" control horns used on rudder and elev.
1/4" sq. stiffener
1/8" ply former 3/16" if using nose U/C.
5/32" wire
2½"-3" wheels. If using nose wheel move main wheels back 6" aft of L.E.
3/8" sq. trim rails
3/16" sheet bottom
3/32" sheet sides
1/16" wire
1" wheel
8½"
Aileron servo in wing. Mount on 1/16" ply
Elev. servo
Trim servo
Trim bar
3/8" maple motor mount
1/2" x 5/8" wing saddles
Rudder servo
Motor servo
Mount u/c on 3/8" x 5/8" maple bearers
Cover wing with 1/16" sheet
1/16" ply tailplane platform
13½"
1/4" x 1/2"
1/4" sq.
1/4" sheet
5¼"
1/16" sheet shear webs for spars
Aileron bellcrank. Mount on 1/16" ply
35"
1/4" x 5/8" L.E.
1/8" x 1/4" spruce spars
Balsa block tips Hollow out
13¼"
SCALE 1 : 12
5°
1/4 size wing rib

PROPORTIONAL

BY
GEOFFREY D. PIKE

For anyone who is still pondering the question of reeds versus proportional, it might be worthwhile for him to consider one particular observation that I have made. That once a "reed-pilot" has made a couple of flights with a *good* proportional control system, he will never again have any desire to fly reeds. Obviously, an ill-functioning radio system is worse than useless, but the same thing applies equally to all systems from single channel to full multi-proportional.

The latest techniques in proportional feedback systems offer a centering (return to neutral) accuracy, which is equal to, or better than, that obtainable with a finely adjusted reed operated servo. This same accuracy however, will also hold good for *any* position, as dictated by control stick deflection from neutral. Therefore, unless one really likes doing things the hard way, there is no difficulty at all in making a decision firmly in favour of proportional. Without a doubt reeds have made a useful contribution to the art of radio control flying, and we were truly grateful for them at a time when there was nothing better. Possibly they will continue to be popular for some time to come, but this can only be on account of their relatively low cost. Full feed-back proportional is necessarily more complex than reeds, and for this reason alone it is bound to cost more to manufacture. Furthermore with so many expert flyers still reluctant to part with their reed systems, we have yet to enjoy the benefit of reduced costs through quantity production—we hope!

This hesitancy, on the part of many flyers to make the switch over to proportional, is understandable in view of the somewhat doubtful performance of some of the early equipment. As with any radically new approach to a big problem, it is not always possible to see just where a design falls short at the outset. One tended to become so excited and enthusiastic about a new concept such as this, that small details like neutralising accuracy and temperature stability went almost unnoticed. Also, since it was so new, one did not know quite what to expect in the way of response. In fact, having grown up with it, as it were, corrections for inaccuracies in the system were being made quite unconsciously. At times, it was hard to judge exactly where a particular fault lay, and trimming a model for top performance became a problem, to say the least. All this, however, is in the dim and distant past (nearly 18 months ago!) and the situation today is very different.

Before discussing further the subject of proportional flying, I would like to digress a little and come back to reeds. From the foregoing it would appear that, at least in my opinion, reeds are now obsolete for top-class flying—and strictly for the birds. This however, would be a travesty of the truth, since I feel that it is essentially the way in which reeds are applied to

FLYING

Geoffrey D. Pike is probably the most experienced British proportional flier. He began full-house proportional flying some years ago with Space Control equipment, and currently uses an F & M Digital 5, digital proportional system. He is seen here with his F & M equipped "Plane Jane", a sleek low wing aerobatic machine of his own design.

model control that is outdated.

Some time ago I wrote an article for the American *Grid Leaks* magazine, in which I described my original "Five-position elevator" experiments. The idea was simply to use all the advantages offered by reed operation, but at the same time to eliminate the undesirable "all or nothing" feature. The only modifications required on a standard 12-channel reed outfit are intermediate stopping positions on the elevator and aileron servo switcher boards, plus new five-position transmitter keying levers for these two controls. At the time when this idea was presented, full proportional was "just around the corner," yet quite a few multi-flyers tried out this scheme. They all reported that it made flying delightfully easy and remarkably smooth. It was generally found that best results were obtained with the new intermediate positions set to give a relatively small deflection but with the "half down" position just sufficient to keep the nose up in an inverted turn. The arrangement dispenses with the usual trim servos in the plane, and only four levers are needed on the transmitter. Properly adjusted, and with surprisingly little practice, it is possible to obtain a performance which in many ways comes remarkably close to the very best in proportional, and at a substantially lower cost. Anyway, if we accept that there is a void between normal reed operation and proportional, perhaps something along these lines might fill the gap.

Returning now to what must be regarded as potentially the most perfect basic system for the control of a model aircraft. This can only mean full simultaneous proportional control of all functions.

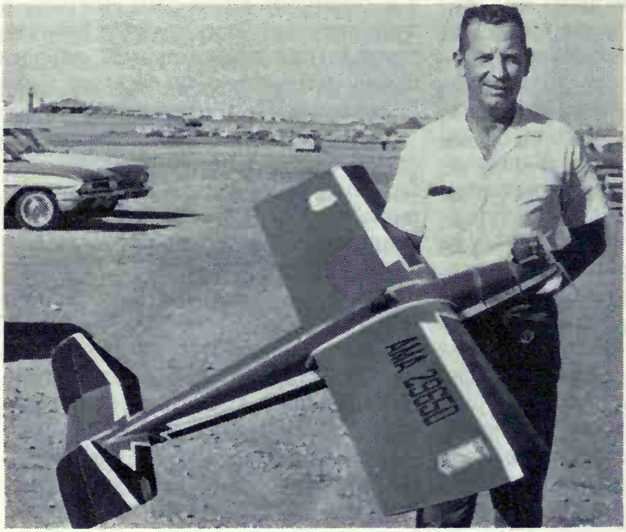
Choice of Model

Since proportional control really has no vices, it is true to say that the best possible performance can be extracted from *any* model design with the facilities offered by proportional. On the other hand, to get the very best out of proportional, one or two model design features can sometimes be modified to advantage. For instance, if the pilot prefers to sustain a banked altitude by holding on aileron, then a small increase in dihedral angle might be incorporated. In an aerobatic model, care should be taken that this is not carried too far, or there is a possibility that the rolls and inverted characteristics may suffer. Some designers have found that a swept wing improves control response. Certainly there is no longer the need for reduced control surface areas in an effort to "hide" the control pulses!

The almost universal adoption of tricycle undercarriages is actually no longer necessary. The art of landing a model gently with proportional is easily mastered and infinitely more rewarding in the form of a fully stalled three-pointer. Unfortunately, ground handling in a high wind can present a problem, and where this is considered important, a steerable nosewheel definitely makes things easier.

Perhaps the best way of acquainting the reader with some of the joys of flying proportional would be for him to make an imaginary flight. For this purpose lets assume a reasonably fine day and that you are all set to make a flight with "Plane Jane." This model is equipped with F. & M. proportional gear, a super Tigre 56 motor, grosses at approximately 7½ lb.

Before starting the engine let's switch on the radio and quickly check all controls. By both looking and listening, we reassure ourselves that there are no mechanical obstructions, nor push-rods or plugs disconnected! No need to check for proper simultaneous operation with equipment of this type. Trim controls should be checked for best position. All is now ready. So with motor ticking-over, you advance the throttle lever slightly—and the wheels are rolling. Notice not only the beautiful smoothness of the steering, but also the "deadbeat" accuracy, with no overshoot or lag. When taxying across wind, it is a simple matter to hold a straight course with a steady application of corrective rudder and nose-wheel.



Californian Willie Smith and his "Torero", a shoulder wing aerobatic model with unusual twin fin layout. Expansive wing area design is equipped with Bonner Digimite proportional system and powered by Super Tigre .56 motor.

Californian Cliff Weirick, U.S. National R/C Champion, 1964 and 1965, and his very successful "Candy" low wing design. Bonner Digimite proportional equipment is employed and powerplant is a Super Tigre .60.

With full throttle now, head into wind for take-off. Concentrating entirely on the left-hand stick, you make slight rudder corrections as required, to keep the model headed in a nice straight line. As flying speed is attained, you can transfer your attention to the right-hand stick. A few degrees of up-elevator will raise the nose, and hold it there for a steady initial climb. At about 100 ft. altitude, allow the elevator stick to return to neutral for level flight. Notice how you have already made several small corrections using the ailerons, almost without realising it. Such is the confidence inspired by this absolute command over the control surfaces. We are thankful that the avoidance of an involuntary half-roll (which at low altitude can be embarrassing) no longer depends on split-second timing of an aileron keying switch, as is the case with reeds. Please forgive the comparisons, but really flying reeds was rather like trying to drive a powerful car through a crowded city with the accelerator pedal hard down—and using the ignition switch for speed control! O.K.! O.K.! so "Plane Jane" is now almost out of sight! . . . sorry about that, let's make a 180 degree left turn. Gently ease the aileron stick a couple of degrees over to the left, then almost immediately ease back on the stick by a similar amount. That's right —now just hold everything . . . watch that angle of bank . . . that's better . . . until the 180 degree turn is complete. Releasing the controls back to neutral now immediately stops the turn, but just give a "squeeze" of right aileron to smartly bring the wings level again. Nothing very difficult so far is there? Fact is that anyone who can fly reeds will find no problem with proportional.

Perhaps even more important is its effect upon a beginner making his very first flight. He will naturally prefer to think in terms of smooth small deviations and corrections, with time to observe the effects of his actions. Many a newcomer has come to grief simply because he could not anticipate the dramatic results when a reed

Brightly coloured design by former World R/C Champion Ed. Kazmirski retains some of the outline of his famous "Taurus" but employs a very thick wing section and has a straight wing trailing edge. Equipped with Orbit Proportional radio.

control is keyed . . . even gently! Yes indeed, proportional may cost more, but we may well expect to see less disappointment in the way of first flight crashes—especially from beginners.

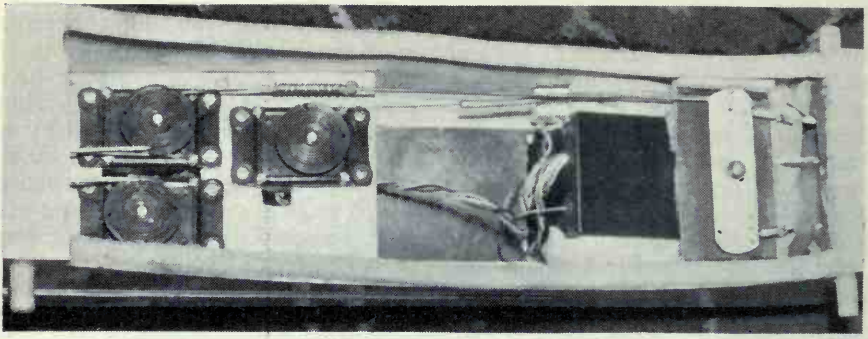
Continuing our flight, let's do one or two aerobatic manoeuvres, starting with a loop. With the model headed directly into wind and with the wings level, just pull smartly back on the stick. About half way back will give us a nice large loop which is more interesting to watch. Hold the stick in this position until the loop is almost complete, now—return it smartly to neutral for a dead level recovery.

Ready for a roll or two now? Well let's first gain a little more height—this will allow you more reaction time, just in case of mistakes! Now you are climbing a little, "hands off" aren't you?—must be due to your having used quite a bit of fuel so she's now slightly nose light—feed in a little down trim. Now for a roll in each direction. You are headed straight into wind so apply just a suggestion of up-elevator to raise the nose very slightly. Release this and bang the stick hard over to the left, pushing a small amount of down in as the model passes through the inverted position. Quickly release the controls as she returns to straight and level flight. Well that was safe enough, but notice how you actually gained height and at the same time veered a little to the left? That was because you applied a little too much down elevator, and a fraction too late. To the right this time, nose raised imperceptably, neutral stick, then full right aileron. Time that touch of down carefully . . . and neutral. That's the idea. You could now do ten consecutive rolls just as easily, but right now how about a spot of inverted? What's that you would rather try a tail slide, certainly, why not. You are at a safe height and heading down wind, so pull the nose up smoothly into an almost vertical climb. Now, with attention focused mainly on the rudder and elevator get her dead vertical and chop the throttle . . . hold everything! She's dropping . . . one, two, three plane lengths—some up elevator quick—and a perfect foward pitch and recovery. Wow! you're really getting the hang of things aren't you.

Let us try and follow that success with another pretty manoeuvre, a spin. Hold the stick back a few degrees with a suggestion of aileron for a fast spiral climb. You are just turning into wind and at a good altitude so throttle right back and neutralise controls. Now, slow the model down by applying some up elevator but keep those wings level if you can—quite tricky this, even with proportional. You are slow and steady now, so apply full up elevator, full rudder, and press the spin button with the right thumb . . . and hold your breath! Lovely, she has entered the spin clean as a whistle, mind now that you don't become hypnotised—right into the ground! Seven . . . eight, see how quickly she's dropping—right, let go of everything . . . no, not the transmitter. Lucky you hooked up that neck-strap! Notice how it is only necessary to neutralise the controls in order to terminate the spin. To complete this manoeuvre you must recover to level flight by pulling back gently on the elevator stick, and you can re-open the throttle at the same time.

So you now feel ready to try a spot of inverted—well it is really quite easy. Particularly if you leave the trim unaltered, the stick *has* to be held forward so that you cannot easily forget that you ARE inverted. With the nose slightly raised, half roll into the inverted position. Follow this with a small application of down elevator just enough to keep flying straight and

For an introduction to proportional control, a model such as this modified Keil Kraft Super 60 is ideal, providing gentle and forgiving characteristics. This model is equipped with an R.C.S. Tetraplex proportional system.



Installation detail showing Orbit proportional system, displays plenty of spare space in the equipment compartment. Bellcrank at right connects to steerable nosewheel.

level. Put the model into a gentle bank, and increase the amount of down as required, for a gentle smooth turn. Notice how the bank is maintained even with neutral ailerons, and that a touch of opposite aileron is occasionally needed. As you turn into wind, prepare to straighten up, combating any tendency to climb with neutral or up elevator. Continue on a straight course, but try to return that stick to its forward position JUST BEFORE such action suggests itself. Only practise will enable the pilot to anticipate accurately such control actions, but therein lies one of the secrets of really smooth flying.

It is an advantage, for your first landing, to be able to descend steadily from a reasonable height. You may throttle back slightly, but slowly gain a little more altitude. Now, cut back to about half throttle, and guide the model so that it passes approximately overhead and into wind. You are now on the approach pattern, competition style, but I consider this good practise even for a beginner. Make a 90 degree left turn across wind. You're doing fine, try throttling down a bit more and apply a little down trim, get ready for your 90 degree turn down wind. You will appreciate that accurate judgment of distance and flying speed are the essential requirements for a good spot landing. You are at about 50 ft. altitude and quite far enough down wind so make your next 90 degree turn across wind. You are getting nice and low now so reduce flying speed a little but not too much. Ready now for that final turn into wind—remember your motor is still there should you need it. Easy now and don't over bank, straighten up, and you are all set for a good landing. Be sure to enjoy this next bit because that is exactly what landing a proportional model really is—sheer enjoyment. More coarse movements of the stick are now required, as the flying speed is reduced. Concentrate on keeping level and be ready for any unexpected gusts, and at about 2 ft. above ground start easing on the up-elevator. Slowly at first, then progressively faster as the flying speed drops. Avoid any tendency to zoom by momentarily relaxing on the up elevator, but do not let it go once you are slowed right down or you will be landing like a dead duck! Well once again the wheels are rolling and you are safely on the ground. The motor is still ticking over so swing her round and we will save ourselves a walk.

Imaginary that might have been, but I can assure the reader that it is far from being unrealistic. Only two assumptions have been made regarding the above pupil. Firstly that he has already become fairly proficient at multi reed flying, and secondly, that he has felt for a long time that proportional must surely be the easiest and best way of controlling a model aircraft.

I make this second point because I have found that when an ex-reed flier thinks in this way, he will have no inclination to "pulse" his new control system, no matter for how long he has flown reeds.

I will now attempt to cover one or two of the finer points on the flying of proportional.

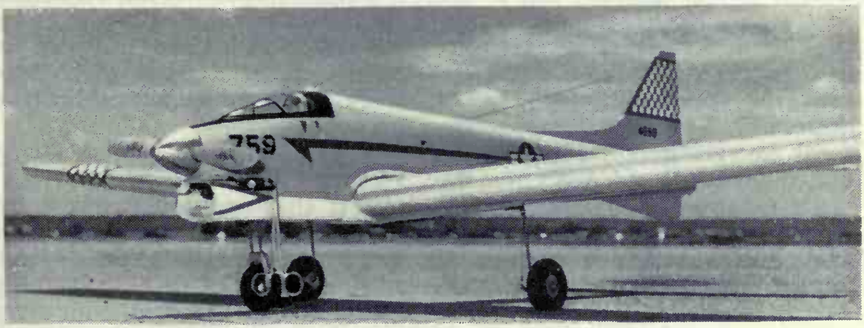
Trimming

The provision of "in flight" trim controls on all surfaces does not of course eliminate the necessity for correct rigging and balancing of the model. This should follow normal practise as for any multi model with due attention to any special comments made by the designer. With proportional, it is necessary to carefully adjust push-rod lengths so that with all trim levers in their central position—all control surfaces are neutral. On making a test flight, it is then easy to assertain what adjustments may be required on the model simply by observing the positions of the trim levers. Do not be satisfied with the trim until full power straight and level flight can be made with all surfaces at neutral.

Modifications to Equipment

In spite of repeated pleas from manufacturers that we should not tamper with the internal works of our newly acquired gear, I cannot agree with this generalisation. After all, if we were not adept to fiddling around with intricate bits and pieces we would prefer watching a football match anyway. Therefore if you feel like taking a look inside, I would say do so by all means. Learn as much about it as you can. Show your wife all those beautiful little transistors and diodes—she will be most impressed with your bargain!! Quality of workmanship is generally to a high standard. Nevertheless, modellers who have perhaps built their own equipment in the past, may well choose to thoroughly inspect every connection, or at least the visible ones. It is probably true that most multi fliers with a few seasons flying under their belts, have at sometime or other had the misfortune to crash as the direct result of either a faulty soldered joint or a fractured lead. Such an experience makes a deep impression (mostly in the ground). Furthermore it helps one

Pleasingly refreshing in outline, this "Crusader" by 1963/64 World R/C Champion Dr. Ralph Brooke, U.S.A., uses Orbit proportional radio. Scissors crimp fuel line and prevent undesired flooding of motor.



to develop a keen eye which can quickly detect any likely trouble spots. Of course one does not even have to understand how a circuit functions in order to deal successfully with such matters. Thoroughly testing all controls before making that initial flight is desirable certainly, but this alone does not assure the pilot that all is as well as it could be. Disaster—which may have been avoidable—could be waiting just around the corner.

Modifications on the other hand are usually best left until the operator has become well acquainted with his equipment, and its shortcomings—if any. Obviously, the reader will have his own ideas on possible improvements to his own particular brand of gear. The golden rule here is to consider most carefully whether the proposed modifications or additions will, in fact, effect an improvement. I would suggest if in doubt, leave it out. In any case some sort of preliminary test is advisable BEFORE drilling any holes.

After flying my own F. & M. proportional equipment for about three months, I decided to go ahead with a couple of ideas which had been suggesting themselves for some time. Firstly, when using this and similar transmitters with a neck strap, it is convenient to allow the control-panel to assume a near horizontal attitude. This is just fine, except that as the pilot swings himself around, anyone standing in his immediate vicinity is liable to get a nasty poke in the eye from the aerial. By making a 75 degree swivel arrangement where the aerial emerges from the top of the case, this is eliminated. Apart from the much reduced risk of losing friends and assistants, I also run less risk of losing my model. The area of weakest signal is now high up, directly overhead. If one is going to experience a temporary loss of control . . . this is surely the safest place to do it.

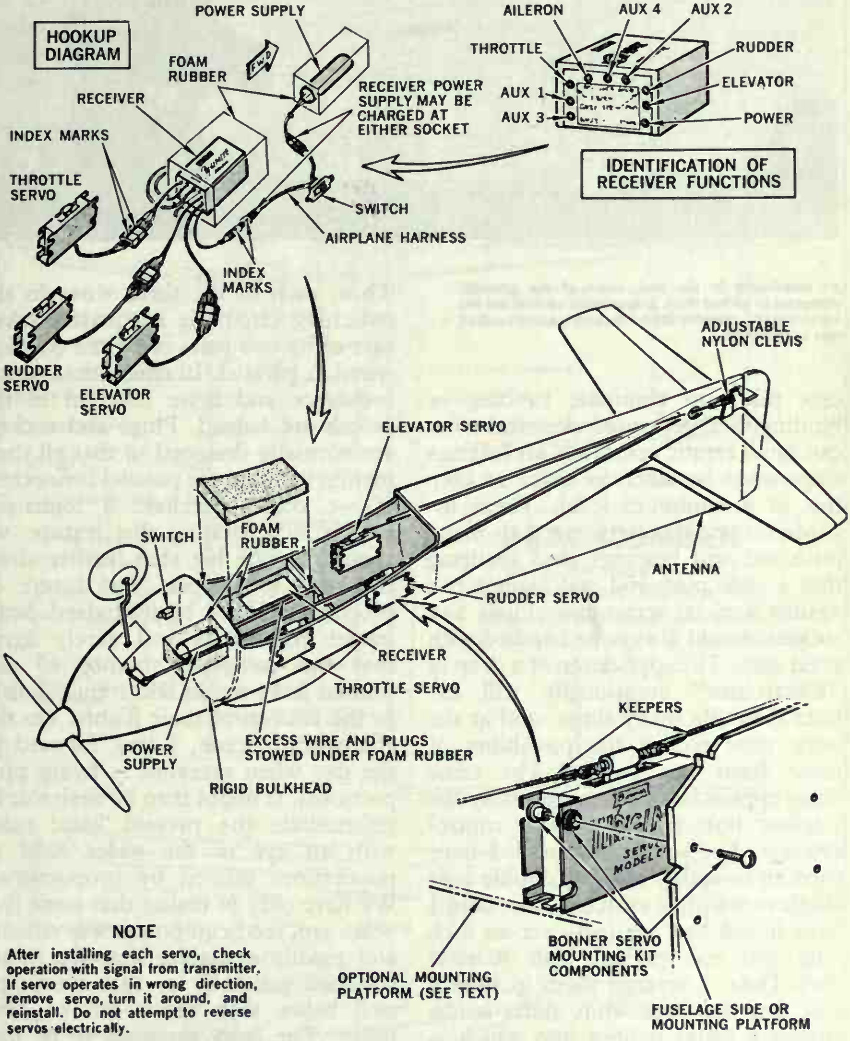
The other alteration to the standard equipment concerns the provision of additional up elevator for "surefire" spins. The work involved here has proved well worth while, particularly as it took less than an hour to do the whole job. The total available travel of the Bonner Duramite feed-back servo was increased slightly by knifing away half the thick tooth at the "up" end of the sector. On the transmitter there is a conveniently placed push button which really serves no useful purpose. Originally I believe it was intended for the load voltage testing of a dry battery installation. Since everyone now uses nickel cadmium cells it could just as well have been omitted. Fortunately however it was not, and provided an obvious choice for use as a "spin" button. After clipping off unwanted wires the push button was then connected in series with a new 2k pot. This was mounted in the chassis opposite to the "AUX" control, and arranged for internal screwdriver adjustment. The two leads from the added circuit were then soldered onto the lower pair of terminals on the elevator trim pot. A second button arrangement may be wired between the middle and top terminals if inverted spins are required. Either way however, the effect is to make available double the normal elevator deflection, simply by pressing this button. Adjustment of the 2k pot enables the total travel to be kept safely within the mechanical limits of the servo.

Installation

This should generally follow the manufacturer's recommendations, and with the pre-wired units of today it is a relatively simple task. Push rods should be stiff and light, with every

Installation Detail

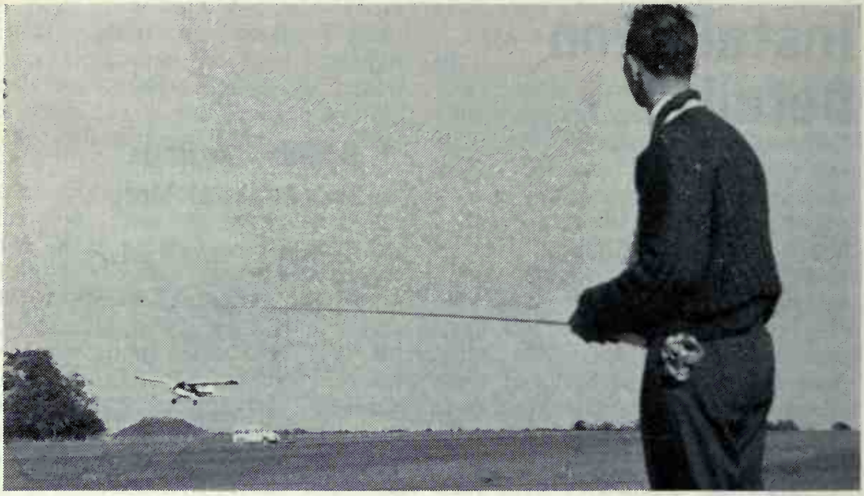
Bonner Digimite Proportional Unit


HOOKUP DIAGRAM
POWER SUPPLY
FOAM RUBBER
FWD
RECEIVER
INDEX MARKS
THROTTLE SERVO
RECEIVER POWER SUPPLY MAY BE CHARGED AT EITHER SOCKET
SWITCH
AIRPLANE HARNESS
INDEX MARKS
RUDDER SERVO
ELEVATOR SERVO
AILERON
AUX 4
AUX 2
THROTTLE
RUDDER
AUX 1
ELEVATOR
AUX 3
POWER
IDENTIFICATION OF RECEIVER FUNCTIONS
ADJUSTABLE NYLON CLEVIS
ELEVATOR SERVO
SWITCH
FOAM RUBBER
ANTENNA
RUDDER SERVO
RECEIVER
THROTTLE SERVO
POWER SUPPLY
EXCESS WIRE AND PLUGS STOWED UNDER FOAM RUBBER
RIGID BULKHEAD
KEEPERS
BONNER SERVO MOUNTING KIT COMPONENTS
OPTIONAL MOUNTING PLATFORM (SEE TEXT)
FUSELAGE SIDE OR MOUNTING PLATFORM

NOTE

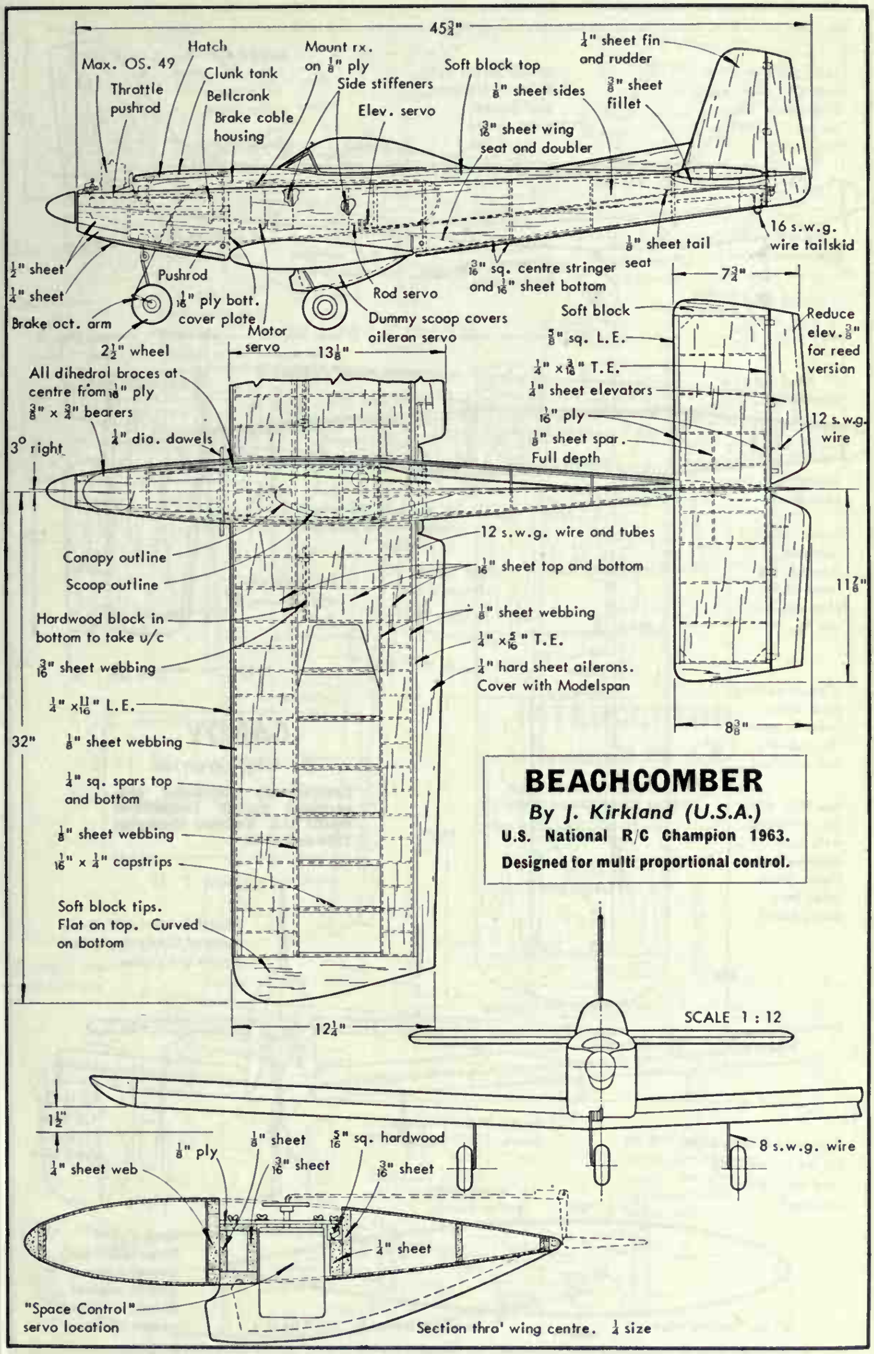
After installing each servo, check operation with signal from transmitter. If servo operates in wrong direction, remove servo, turn it around, and reinstall. Do not attempt to reverse servos electrically.

Taken from Bonner Digimite Instruction Manual



As mentioned in the text, some of the greatest pleasures to be had from proportional control are the exceptionally realistic take-offs and landings which can be achieved.

care taken to eliminate rubbing or binding. Self generated electrical noise can cause erratic operation, and certain steps must be taken in order to keep this at a minimum level. These include the avoidance of metal to metal push-rod and bearings, and ensuring that a wire push-rod end cannot rub against a metal servo case. Plugs and sockets should always be handled with great care. The application of a drop of "Electrolube" occasionally will extend their life many times, and at the same time reduce the possibility of noise from this source. The same thing applies to switches—possibly the weakest link in most radio control systems. For some years now I have used an assembly of three double pole single throw slide switches. The ones I have found best are just over an inch long and are marked Jean Renaud Paris-Dole. I arrange them in such a way that the three white slider knobs engage a metal bobbin into which is screwed an actuating push-pull rod. Thus, each of the three wires in the switching circuit is adequately taken care of by two pairs of switch contacts wired in parallel. In effect, the contact resistance and noise inherent in the switch are halved. Plugs and sockets are normally designed so that all their mating surfaces are parallel connected. If we could purchase a miniature switch incorporating this feature, we should be one big step further along the road to Utopia. The future of proportional looks bright indeed. Scale model enthusiasts will surely agree that the complete absence of unwanted jerks would add tremendously to the realism of their flights. On the competition scene, I look forward to the day when everyone is flying proportional. It might then be desirable to reformulate the present basic rules with an eye to the wider field of possibilities offered by proportional. We have only to realise that some five years ago, reed equipment was reliable and readily available. Yet, the flying standard generally at that time, fell well below that which can be seen today. The story promises to be just the same with proportional.

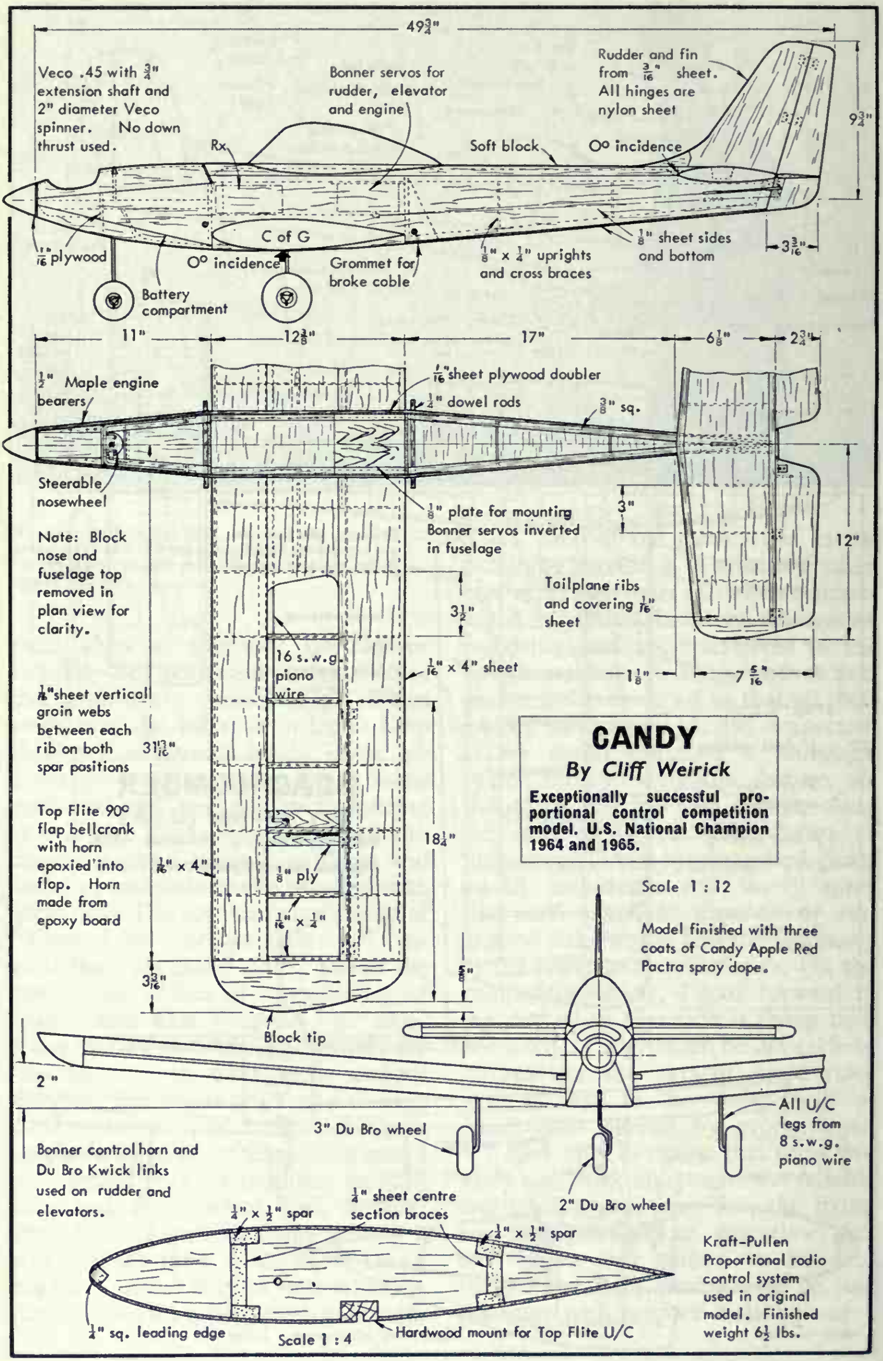

45¾"
Max. OS. 49
Throttle pushrod
Hatch
Clunk tank
Bellcrank
Brake cable housing
Mount rx. on ⅛" ply
Side stiffeners
Elev. servo
Soft block top
⅛" sheet sides
3/16" sheet wing seat and doubler
¼" sheet fin and rudder
⅜" sheet fillet
16 s.w.g. wire tailskid
⅛" sheet tail seat
3/16" sq. centre stringer and 1/16" sheet bottom
½" sheet
¼" sheet
Pushrod
Brake act. arm
1/16" ply bott. cover plate
Motor servo
Rod servo
Dummy scoop covers aileron servo
2½" wheel
13⅛"
7¾"
Soft block
⅝" sq. L.E.
¼" x 3/16" T.E.
¼" sheet elevators
1/16" ply
⅛" sheet spar. Full depth
Reduce elev. ⅜" for reed version
12 s.w.g. wire
11⅞"
8⅜"
All dihedral braces at centre from 1/16" ply
⅜" x ¾" bearers
¼" dia. dowels
3° right
Canopy outline
Scoop outline
Hardwood block in bottom to take u/c
3/16" sheet webbing
¼" x 11/16" L.E.
32"
⅛" sheet webbing
¼" sq. spars top and bottom
⅛" sheet webbing
1/16" x ¼" capstrips
Soft block tips. Flat on top. Curved on bottom
12 s.w.g. wire and tubes
1/16" sheet top and bottom
⅛" sheet webbing
¼" x 5/16" T.E.
¼" hard sheet ailerons. Cover with Modelspan
12¼"
SCALE 1 : 12
1½"
8 s.w.g. wire
¼" sheet web
⅛" ply
⅛" sheet
3/16" sheet
5/16" sq. hardwood
3/16" sheet
¼" sheet
"Space Control" servo location
Section thro' wing centre. ¼ size

BEACHCOMBER

By J. Kirkland (U.S.A.)

U.S. National R/C Champion 1963.

Designed for multi proportional control.

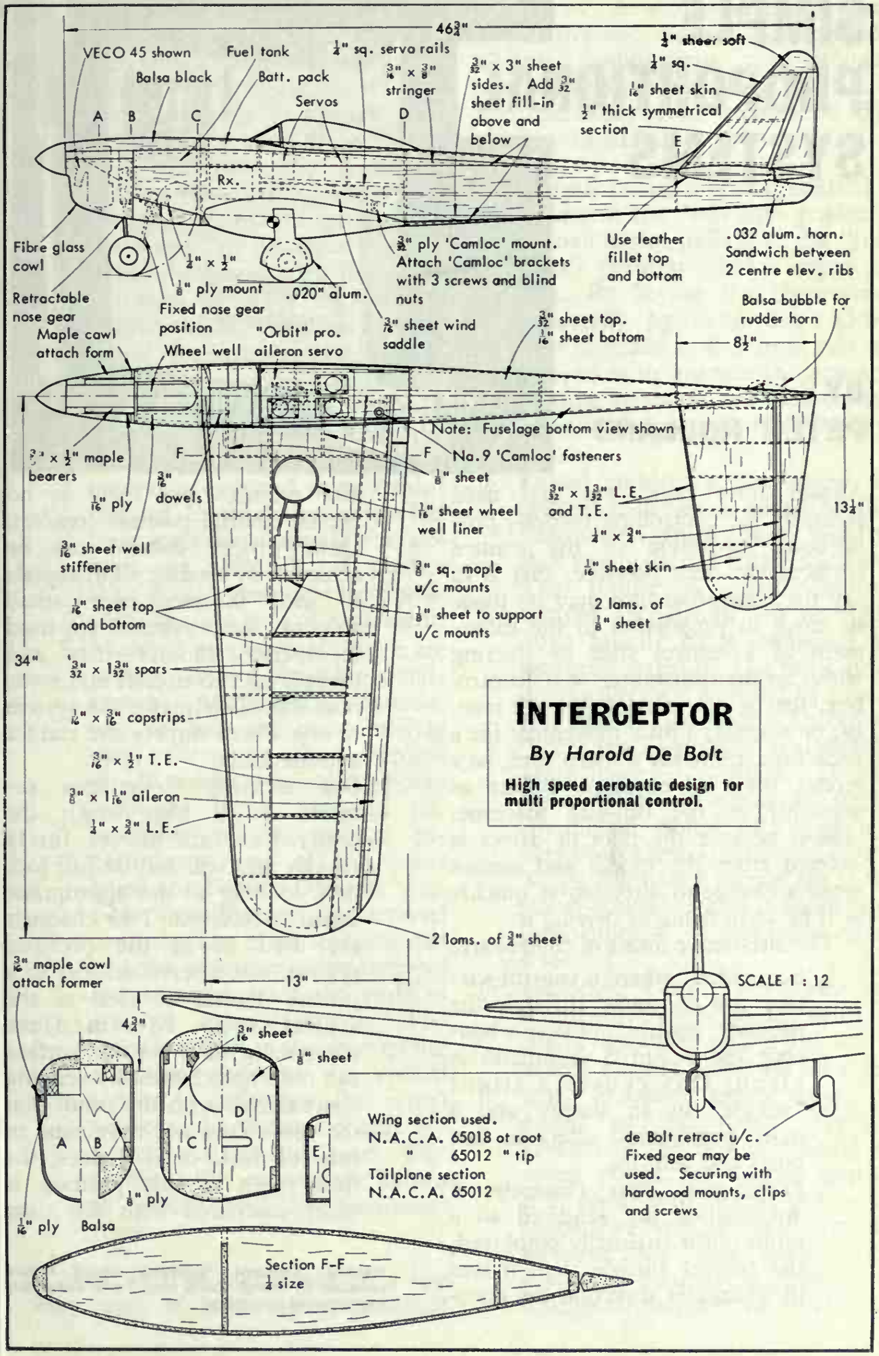


49¾"
Veco .45 with ¾" extension shaft and 2" diameter Veco spinner. No down thrust used.
Bonner servos for rudder, elevator and engine
Rudder and fin from 3/16" sheet. All hinges are nylon sheet
9¾"
Rx
Soft block
0° incidence
C of G
1/16" plywood
0° incidence
Grommet for broke coble
⅛" x ¼" uprights and cross braces
⅛" sheet sides and bottom
3 3/16"
Battery compartment
11"
12⅜"
17"
6⅛"
2¾"
½" Maple engine bearers
1/16" sheet plywood doubler
¼" dowel rods
⅜" sq.
Steerable nosewheel
⅛" plate for mounting Bonner servos inverted in fuselage
3"
12"
Note: Block nose and fuselage top removed in plan view for clarity.
3½"
Tailplane ribs and covering 1/16" sheet
16 s.w.g. piano wire
1/16" x 4" sheet
1⅛"
7 5/16"
1/16"sheet vertical grain webs between each rib on both spar positions
31 13/16"
18¼"
Top Flite 90° flap bellcrank with horn epoxied into flap. Horn made from epoxy board
1/16" x 4"
⅛" ply
1/16" x ¼"
3 3/16"
⅝"
Block tip
Scale 1 : 12
Model finished with three coats of Candy Apple Red Pactra spray dope.
2"
3" Du Bro wheel
All U/C legs from 8 s.w.g. piano wire
2" Du Bro wheel
Bonner control horn and Du Bro Kwick links used on rudder and elevators.
¼" x ½" spar
¼" sheet centre section braces
¼" x ½" spar
Kraft-Pullen Proportional radio control system used in original model. Finished weight 6½ lbs.
¼" sq. leading edge
Scale 1 : 4
Hardwood mount for Top Flite U/C

CANDY

By Cliff Weirick

Exceptionally successful proportional control competition model. U.S. National Champion 1964 and 1965.


46 3/4"
VECO 45 shown
Fuel tank
1/4" sq. servo rails
1/2" sheet soft
Balsa block
Batt. pack
3/16" x 3/8" stringer
3/32" x 3" sheet sides. Add 3/32" sheet fill-in above and below
1/4" sq.
1/16" sheet skin
1/2" thick symmetrical section
Servos
A
B
C
D
E
Rx.
Fibre glass cowl
1/4" x 1/2"
1/8" ply mount
.020" alum.
3/8" ply 'Camloc' mount. Attach 'Camloc' brackets with 3 screws and blind nuts
Use leather fillet top and bottom
.032 alum. horn. Sandwich between 2 centre elev. ribs
Retractable nose gear
Fixed nose gear position
3/16" sheet wind saddle
Maple cowl attach form
Wheel well
"Orbit" pro. aileron servo
3/32" sheet top. 1/16" sheet bottom
Balsa bubble for rudder horn
8 1/2"
Note: Fuselage bottom view shown
No.9 'Camloc' fasteners
3/8" x 1/2" maple bearers
F
F
1/8" sheet
3/16" dowels
1/16" ply
1/16" sheet wheel well liner
3/32" x 1 3/32" L.E. and T.E.
13 1/4"
1/4" x 3/4"
3/16" sheet well stiffener
3/8" sq. maple u/c mounts
1/16" sheet skin
1/16" sheet top and bottom
1/8" sheet to support u/c mounts
2 lams. of 1/8" sheet
34"
3/32" x 1 3/32" spars
1/16" x 3/16" capstrips
3/16" x 1/2" T.E.
3/8" x 1 1/16" aileron
1/4" x 3/4" L.E.
2 lams. of 3/4" sheet
3/16" maple cowl attach former
13"
SCALE 1 : 12
4 3/4"
3/16" sheet
1/8" sheet
1/8" ply
1/16" ply
Balsa
Wing section used.
N.A.C.A. 65018 at root
" 65012 " tip
Tailplane section
N.A.C.A. 65012
de Bolt retract u/c. Fixed gear may be used. Securing with hardwood mounts, clips and screws
Section F-F
1/2 size

INTERCEPTOR

By Harold De Bolt

High speed aerobatic design for multi proportional control.

SIMPLE PROPORTIONAL SYSTEMS

MIN-X
PULSMITE 8002
MIN-X
Capri

BY PETER HOLLAND

Almost since radio was first used seriously for controlling models, proportional operation of the control surfaces has been possible; that is to say the control surface may be made to move in proportion to the movement of a control stick or steering wheel on the transmitter or its control box. Just as one steers a full size boat, car or aircraft; a little movement for a wide turn, more for a sharp turn, so a model may be operated almost as smoothly as the full-size machine. *Almost* because the pilot or driver is isolated from the model and cannot sense a change in direction as quickly as if he were flying or driving it.

The alternative forms of control are:

1. Sequential; where a control surface has to move through the opposite control position whenever the required command is given, this causes a slight "wiggle" in an aircraft and a more pronounced effect in fast boats and vehicles.
2. Progressive; two channels of information are required so a multi outfit is usually employed, the control surface then moves in whichever direction the operator requires but there is no precise neutral position (centre). Quite precise control can be achieved by sending short signals to "inch" the servo over a small amount. Such systems are used to operate elevator trim and throttle on the aircraft and some boat modellers prefer the system to one which centres the rudder automatically.
3. Self centring (sometimes referred to as bang-bang); the control surface moves fairly rapidly and will stay at full lock only so long as the appropriate signal is received. Two channels are used as in the previous system, but a servo returns to a precise neutral as soon as the signal stops. Intermediate positioning of a control surface can only be achieved by sending short signals with the result that the servo does not have time to run full lock, or if it does, the time spent at this position is short compared with the time

Heading: Excellent "Galloping Ghost" system produced by Min-X Radio Inc., has a completely transistorised transmitter.

spent at neutral with the result that the model executes a wide turn with a slight "wiggle" as the control surface oscillates. This system is safer to operate than system 2, for should the signals be lost whilst the model is turning the servo returns to neutral, whereas a progressive servo stays in whatever position it had been set, with the result that with an aircraft the turn will tighten up. No comment!

4. Three tone progressive; a less well known system sometimes used by boat and vehicle modellers which is basically the same as progressive but a precise neutral is obtained from a third channel. So far such a system has been considered unsafe for aircraft use although we predict that it can become acceptable with the right kind of equipment.
5. Multiple proportional; there are various ways of obtaining simultaneous proportional controls, one or two are comparatively easy, three or four become rapidly more complex, more than four are usually beyond the capability of the average experimenter, one of the latest being the Bonner Digimite with eight simultaneous proportional controls. The more sophisticated systems consume comparatively low currents when the surfaces are not actually moving. The servo is driven in the appropriate direction whenever the system senses a difference (or error) between the command and the actual control position. The servos in this instance are known as "closed loop" or "feedback" types.

Now let's go right back to a few easy ways of achieving proportional control. . . . A simple single channel transmitter and receiver can be used, a few modifications can provide worthwhile improvements. There are five commonly used variants on the single channel field. . . .

(*a*) Manual pulse; a spring holds the rudder in the "full left" position, a small motor pulls it to the "full right" position when a signal is sent. By keying the transmitter repeatedly by hand the rudder may be made to flap from side to side, so with practice the amount of time spent on one side or the other can be controlled to provide a turn.

(*b*) Pulsed rudder; a mechanical or electronic device is added to the transmitter, which it keys rapidly, thus saving the old thumb muscles. The rudder is usually spring centred and driven left or right quite rapidly by a motorised or magnetic actuator. The pulse producing device is adjusted by a control stick so that what is known as "mark/space variation" is achieved. Mark/space ? . . . "Mark" is the signal, "Space" means no signal (thumb on, thumb off) to go left very short signals (mark) are given. To go right long signals are given (short spaces) all this is happening quite quickly. . . . Say seven times a second.

(*c*) Galloping Ghost, sometimes referred to Simpl-Simul; using a slightly modified pulser unit and a geared electric motor for an actuator, elevator control may be added to the rudder system. Instead of the pulser running at seven pulses per second (p.p.s.) it is possible to change this pulse speed (we call it rate) without affecting the mark/space. The system is basically a mechanical linkage so designed to provide up elevator effect if the pulser rate is low (2 p.p.s.) and down elevator effect at a high rate (20 p.p.s.). Changing the mark/space ratio between 20/80% or 80/20 controls the rudder. Both controls may be operated together to obtain simultaneous variation of rudder and elevator. It is usual to have a two-way joystick on the transmitter or pulser so that a fairly natural type of control feed is obtained.

(*d*) P.O.D. (pulse omission detector); this may be added to any of the systems and senses a lack of pulsing so that this additional information can be used to operate a throttle or to mechanically centre the controls. In this connection it is used as a fail-safe. Most simple proportional systems do not use a fail-safe on the basis that an aircraft will spiral down rather than fly away. . . . Bent 'uns are better than lost 'uns.

This then, is a basic analysis of the simpler types of proportional control, now let us deal in detail with the constructional approach.

Manual Pulse

Practically any transmitter may be used; single or multi. If it has a light action keying button so much the better. If the receiver is not sensitive to interference produced by a small electric motor such as a geared Mighty Midget or Micromax T05 or T03 with gearing, then it may be wired in place of an escapement. Most escapements have a resistance of 7–10 ohms, add a fixed resistor of about 4·7 ohms, half watt in series with the motor so that the output of the receiver is not overloaded.

A pin soldered to the pulley of the Mighty Midget motor serves as a fixing point for a piece of thread which is then taken two or three turns round

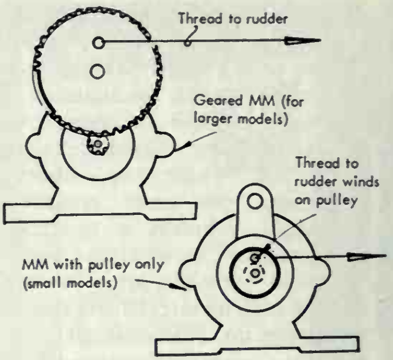

Thread to rudder
Geared MM (for larger models)
Thread to rudder winds on pulley
MM with pulley only (small models)

Fig. 1a

Fig. 1b

Fig. 2

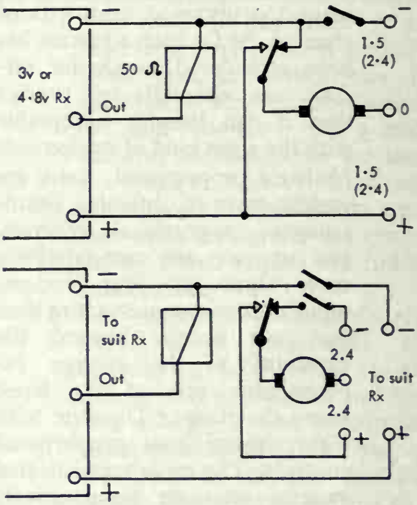
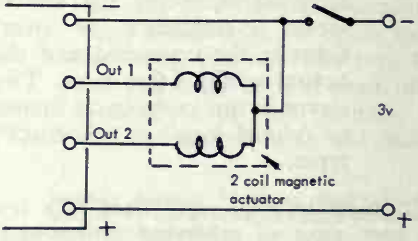

−
3v or 4·8v Rx
50 Ω
Out
1·5 (2·4)
0
1·5 (2·4)
+
+
−
To suit Rx
Out
−
−
2.4
To suit Rx
2.4
+
+
+

Fig. 3


−
−
Out 1
Out 2
3v
2 coil magnetic actuator
+
+

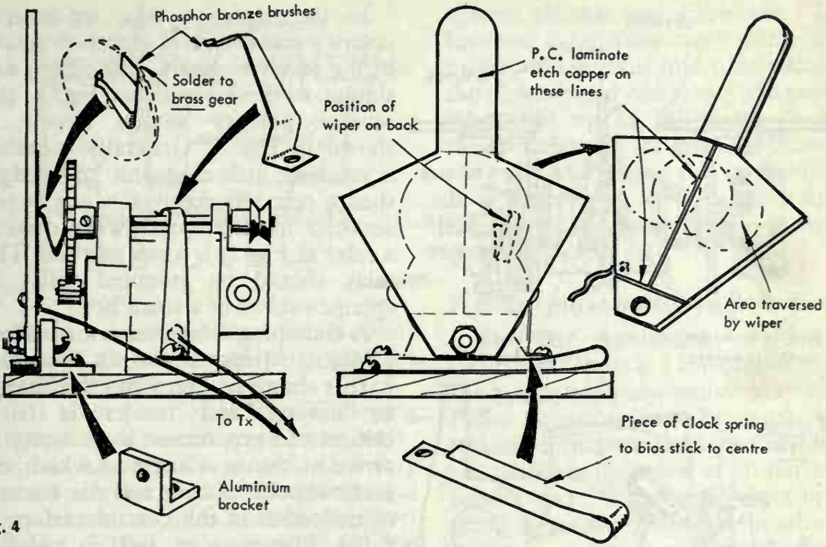

Phosphor bronze brushes
Solder to brass gear
To Tx
Aluminium bracket
Position of wiper on back
P.C. laminate etch copper on these lines
Area traversed by wiper
Piece of clock spring to bias stick to centre

Fig. 4

the pulley, then to the rudder horn. A spring on a second rudder horn on the opposite side should be just strong enough to wind the motor back. Adjust this spring to obtain best results. If you have a relay receiver or add a 100 ohm relay to a relayless receiver in place of an escapement, then a separate centre tapped servo battery can be used, in this case a torque rod or pushrod operates the rudder which is then spring centred and driven in both directions by the motor. Figs. 1 and 2 show both ideas.

If a receiver is sensitive to interference then it is necessary to use a magnetic actuator. This has no brush gear but is less powerful. It may be operated by a relay or a "double ended" output relayless receiver. Magnetic actuators are mainly of American origin, the Septalette, Adams and Pouvoir are typical examples. They need to be wired as shown in Fig. 3.

Rudder only Pulse

Precisely the same systems as those shown in Figs. 2 and 3 may be used in the model. The pulser may be made separately and clamped on the Tx. If you have little electronic knowledge and wish to build a pulser, take a small geared motor such as the Might Midget and follow the details shown in Fig. 4. The Glass City dual proportional system quite popular today, is an example of modern mechanical pulsing.

An electronic pulser is not difficult to construct and if a relay is used to switch the transmitter there is unlikely to be any trouble in matching the pulser to different types of transmitter. The Tx. keying button connections are wired to the normally open relay contact and the armature. Leave the keying button in the circuit so that the Tx. can be used for normal operation with the pulser switched off.

Galloping Ghost

A rate control addition to the pulser comprises a variable resistor in the battery lead to the pulser motor. There are several ways of operating the pulser controls, a mechanical linkage is shown in Fig. 5.

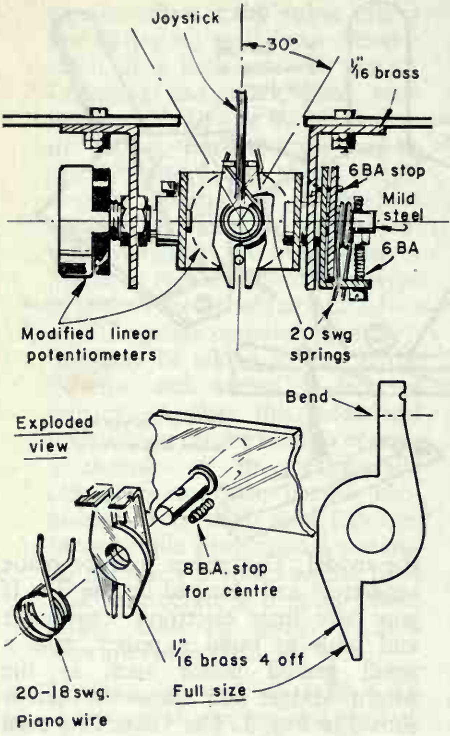
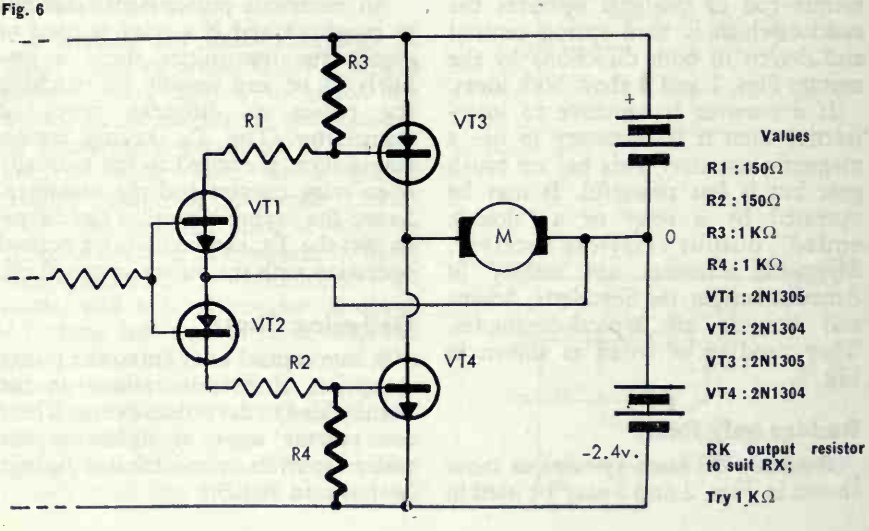

Joystick
30°
1/16" brass
6BA stop
Mild steel
6 BA
Modified linear potentiometers
20 swg springs
Bend
Exploded view
8 B.A. stop for centre
1/16" brass 4 off
Full size
20-18 swg. Piano wire

Fig. 5

In the model, a relay or reverse polarity transistorised switch is added to the receiver. Relay connections are similar to those shown in Fig. 2, the reverse polarity switch circuit is shown in Fig. 6. Generally speaking if you have little electronic knowledge, then a relayless receiver which is not sensitive to interference when driving a relay as Fig. 2, is a safe method. The relay should be mounted softly in sponge rubber in a small box.

A Galloping Ghost servo made from a Mighty Midget motor can be similar to that shown in Fig. 7 but the linkage to elevator and rudder is fairly critical and experiment is necessary to arrive at the best angle to which the crank should be bent and the amount of deflection of the control surface at full rudder position, full up and full down. Such adjustments are made by adding washers to the elevator yoke and bending the rudder yoke nearer to or further from the trailing edge. Fig. 8 shows the yoke system. There are many variants and the bent wire and paper clip brigade have their own special ideas for improving performance and cutting down friction. It

Fig. 6


R3
R1
VT3
VT1
+
M
0
VT2
R2
VT4
R4
-2.4v.
Values
R1 : 150Ω
R2 : 150Ω
R3 : 1 KΩ
R4 : 1 KΩ
VT1 : 2N1305
VT2 : 2N1304
VT3 : 2N1305
VT4 : 2N1304
RK output resistor to suit RX;
Try 1 KΩ

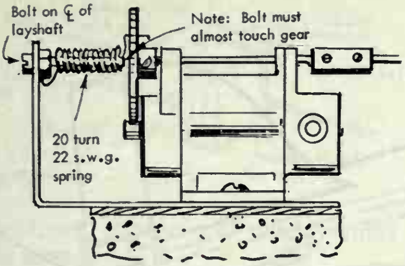
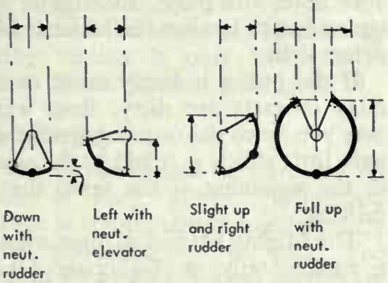

Bolt on ℄ of layshaft
Note: Bolt must almost touch gear
20 turn 22 s.w.g. spring

Fig. 7

should be realised that for accurate control, all mechanical parts must be as free acting as possible.

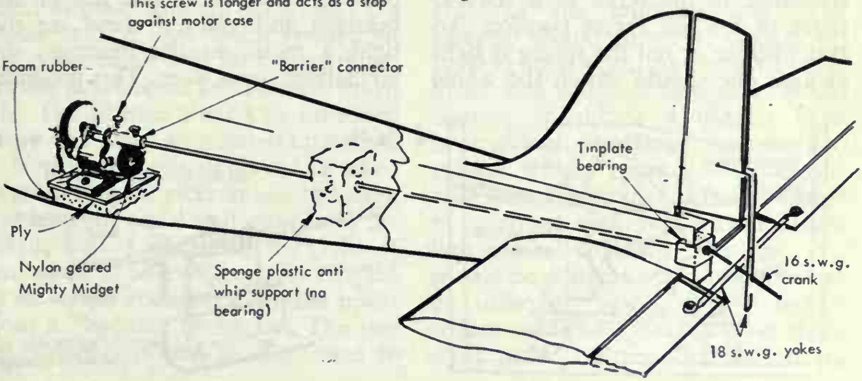
It takes practice to fly a Galloping Ghost model as there is some interaction between the control. If a very small elevator is used, its effect as a pitch trim control is valuable for sport flying. There is a variant on the Galloping Ghost idea which was published in October 1964 *Radio Control Models and Electronics*. This involves a lot more mechanical gimmickry but gives gentle trim action to the elevator and centralises the rudder when full up or full down "solid" elevator controls are given by omitting the pulse and giving full or no signal. It is regrettably a little too complicated to be accommodated in the space available here.


Down with neut. rudder
Left with neut. elevator
Slight up and right rudder
Full up with neut. rudder

P.O.D. (pulse omission detector)

The last mentioned variation to Galloping Ghost is a mixture of mark/space, rate and pulse omission systems. Pulse omission can be used with rudder only control to provide non-simultaneous operation of proportional rudder and "bang-bang" elevator by using a second actuator (usually an ordinary multi servo, sometimes a spring centred Bellamatic multi servo) to operate the elevator. The rudder crank now moves 180 degrees from neutral instead of 90 degrees. The rudder thus returns to neutral but with the crank the other way up. A set of contacts on the torque rod are used to switch the elevator servo up or down. The result is a stuntable model which may be flown as smoothly as an ordinary pulsed rudder type. The engine throttle may be operated by a multi-trim servo instead of the

Fig. 8


This screw is longer and acts as a stop against motor case
Foam rubber
"Barrier" connector
Ply
Nylon geared Mighty Midget
Sponge plastic anti whip support (no bearing)
Tinplate bearing
16 s.w.g. crank
18 s.w.g. yokes

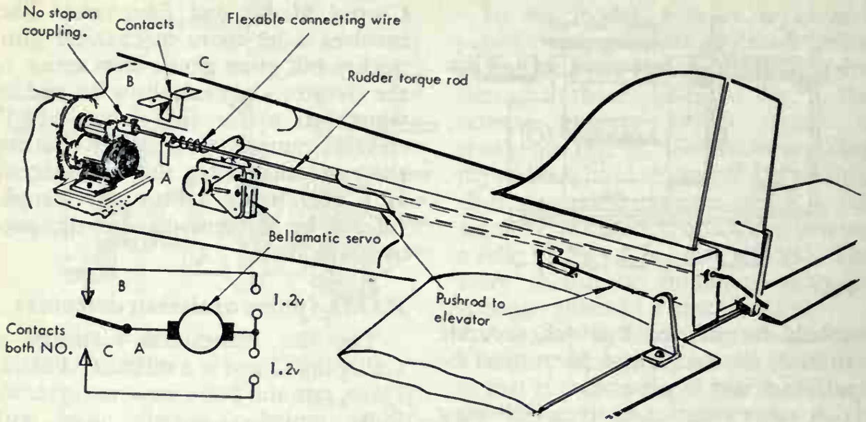

No stop on coupling.
Contacts
Flexable connecting wire
C
B
Rudder torque rod
A
Bellamatic servo
B
1.2v
Contacts both NO.
C
A
1.2v
Pushrod to elevator

Fig. 9

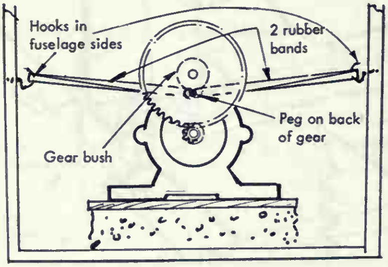
elevator control previously mentioned. This gives progressive speed control and such a system may be used in model boats. The mechanical details appear in Fig. 9.

Centring Springs

A few general observations would seem helpful here; many new ideas have been developed since the original servos for pulsed rudder, Galloping Ghost and Bi-Simpl where developed. It is not necessary to have a centring spring or rubber band so powerful that it pulls the servo back to the neutral position when the servo is switched off. Centring bias is probably a better term for the spring. All it has to do is to offer some mechanical resistance to the servo as it tries to move to the full throw position. To test whether or not the spring is tight enough one should switch the whole system on with the control stick central. If the servo wanders from side to side, the spring is too slack. Tighten it only sufficiently to keep this drift down to an acceptable level. The faster the pulse, the tighter the spring has to be, but the easier it is to detect drift.

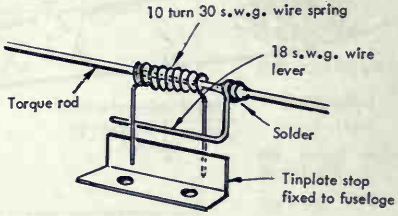
If the pulser is badly made or the relay contacts are dirty, then whatever you do to the centring spring will have little effect, as it will be the signal or the switching of the servo that is drifting.

The Mighty Midget so often used as a rudder only or Galloping Ghost servo is operated in a way which can produce excess wear and tear on the bearings and gears if these are too tight a mesh on the bearings, the layshaft becomes worn. This produces


Hooks in fuselage sides
2 rubber bands
Peg on back of gear
Gear bush

◀ Fig .10

▼ Fig. 11


10 turn 30 s.w.g. wire spring
18 s.w.g. wire lever
Torque rod
Solder
Tinplate stop fixed to fuselage

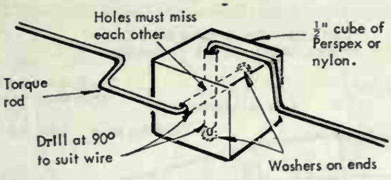

Holes must miss each other
½" cube of Perspex or nylon.
Torque rod
Drill at 90° to suit wire
Washers on ends

Fig. 12

too much friction and quickly ruins the motor.

If *two* weak centring bands are used, each on its own pin on the gear wheel of the motor then very little wear is produced as a result of the loading or biassing device, see Fig. 10. One of the craftiest bias springs recently used was produced by T. B. Tippett. This is a torsion spring mounted on a bolt; A combination of torsion and what is known as "scissors" action which gives a positive neutral "groove" to the centring action may be obtained by using the method shown in Fig. 11 as suggested by E. De Pelsmaeker. Remember, in all cases the spring tension is only sufficient to centre the servo when pulsing 50/50.

Installation

The servos should be mounted on blocks of foam rubber. Torque rod linkage is comparatively unaffected by servo movement on its pad. The brushes of Mighty Midget motors are a push fit and it is advisable to bind them in place with thread around the motor case. A spot of Electrolube on the commutator will inhibit sparking, reduce interference and increase brush life. The brushes should be inspected every two hours aggregated operation.

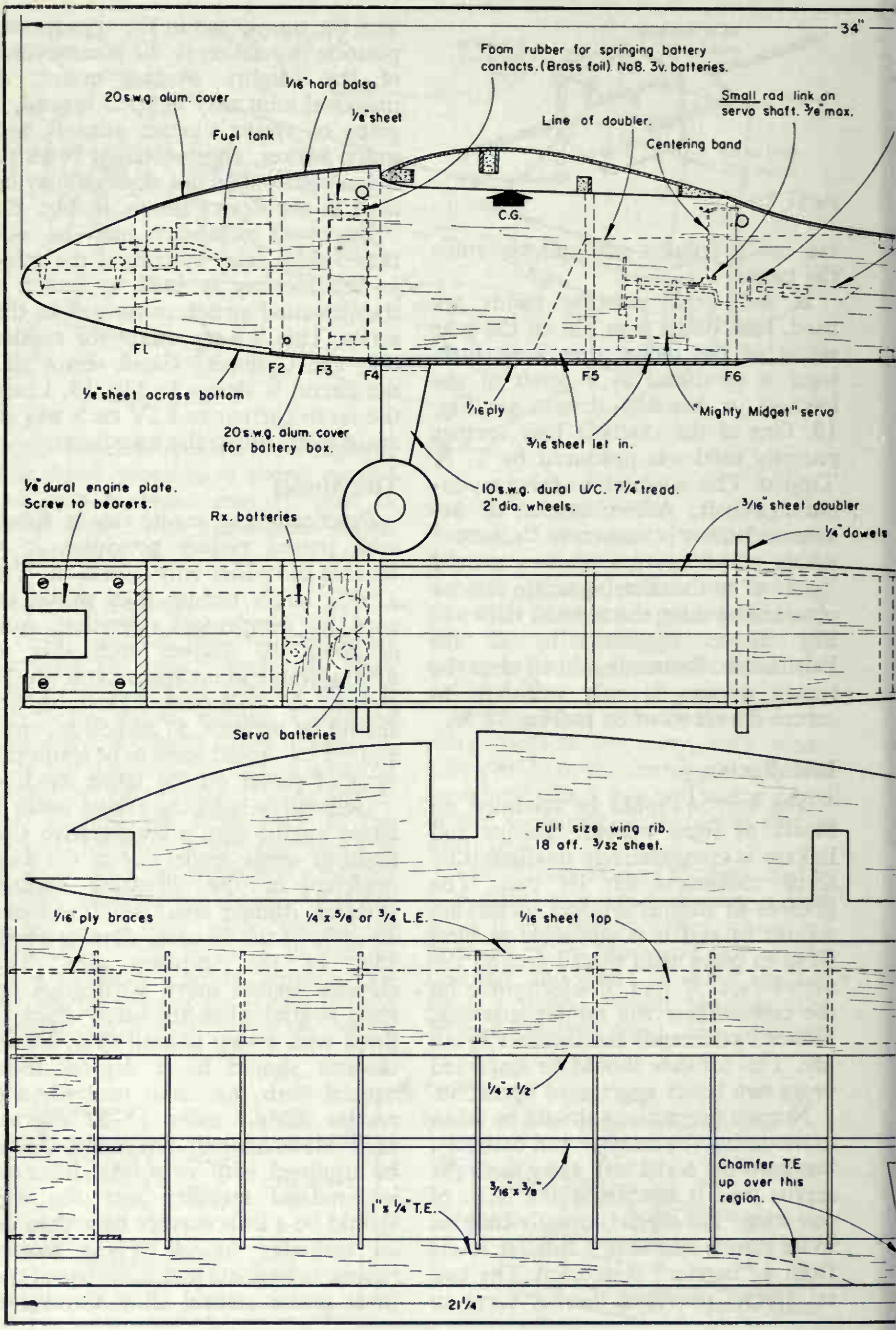
Normal precautions should be taken in mounting the receiver and batteries, but keep the aerial well away from the servo; lead it out along the T.E. of one wing. The servo is usually coupled to its torque rod with a tubular insert from a "barrier" connector. The two set screws provided therein serve to lock the torque rod in the appropriate position in relation to the countershaft of the Mighty Midget motor. A universal joint may be used instead, a piece of spring curtain wire is one quick answer, alternatively a block of nylon cut from an old airscrew may be used in the device shown in Fig. 12.

Improved reliability may be obtained from relay systems if the relay in the receiver is used to switch a transistorised switch connected to the servo. This is very useful for rudder only and Galloping Ghost servos and the circuit is shown in Fig. 13. Limit the servo current to 1·5V each way to avoid overloading the transistors.

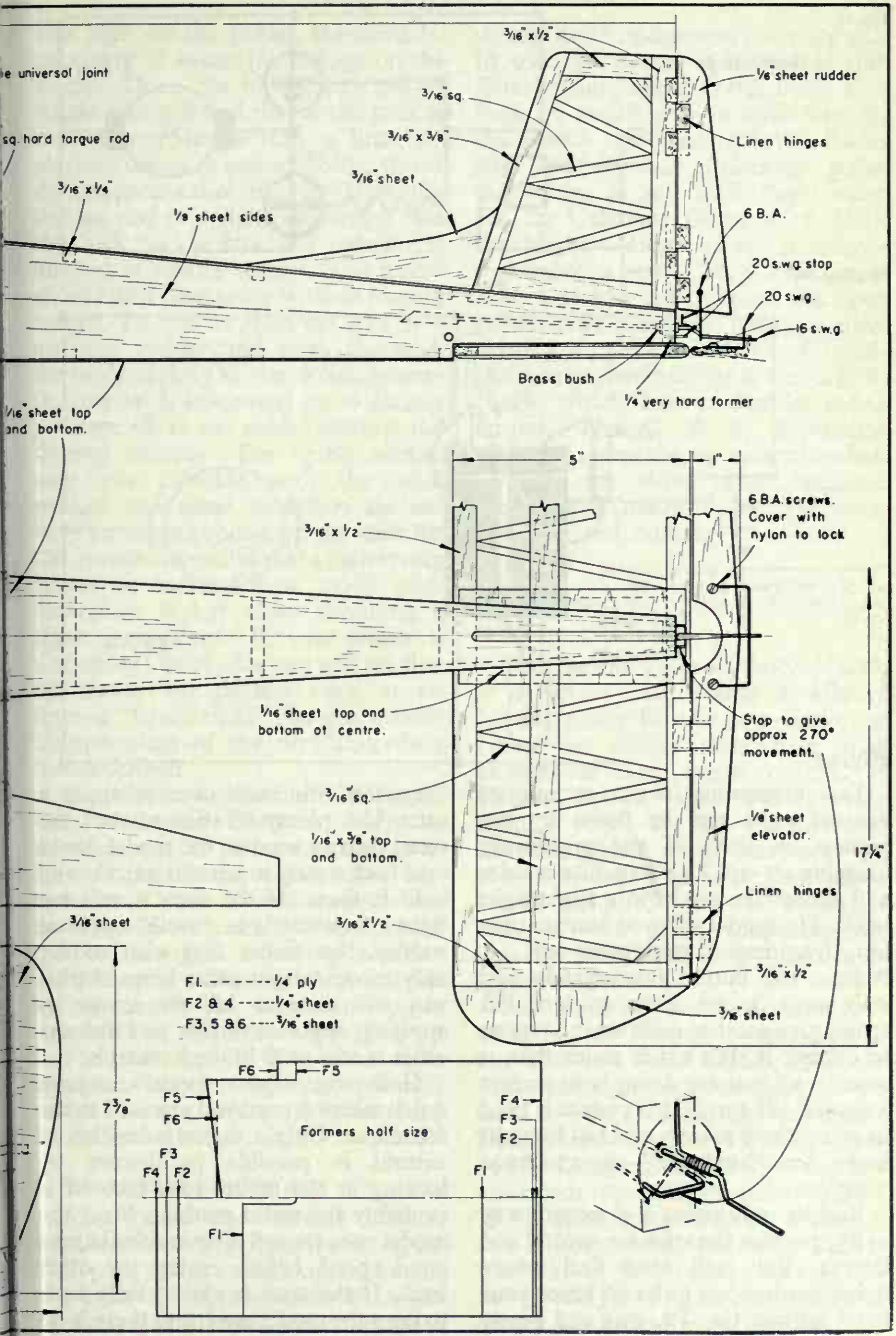
The Model

Practically any model can be flown with pulsed rudder providing it is capable of rudder only operation. Use a 50% larger rudder than would be used for escapement operation. Aim at about 10 degrees each side of neutral (more is ineffective and wastes power. A Galloping Ghost model should be between 30 and 50 in. span and 3·5 c.c. would seem to be about the limit of power on the larger models.

Generally Galloping Ghost needs a larger engine than a comparative size multi or single model due to the drag involved in the vibrating control surfaces. Rudder area should be about 25–30% of the fin area, elevator about 15% of the tailplane area. The elevator should move 30 degrees up from neutral when the servo which is fitted with a stop is hard over. Down elevator should be 8 degrees from neutral with the servo centred, and rudder should move 15–20 degrees each side of neutral. The model should be trimmed with very little inherent longitudinal stability and the c.g. should be a little further back than on an orthodox model. These factors reduce sponginess and make use of the most gentle control stick movement.

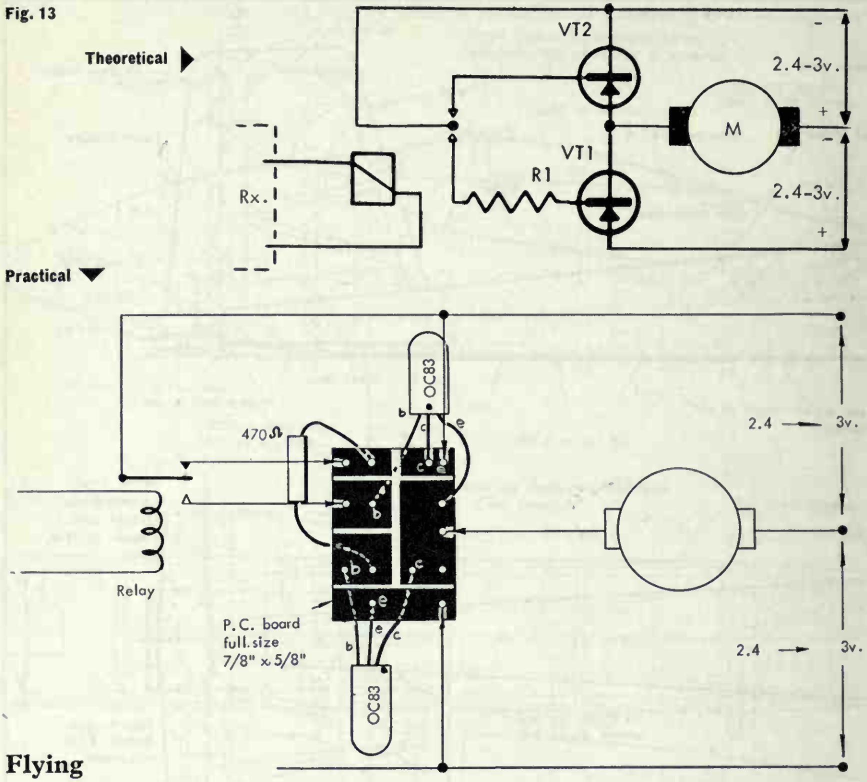

34"
Foam rubber for springing battery contacts. (Brass foil). No8. 3v. batteries.
1/16" hard balsa
20 s.w.g. alum. cover
1/8" sheet
Fuel tank
Line of doubler.
Small rad link on servo shaft. 3/8" max.
Centering band
C.G.
F1
F2
F3
F4
F5
F6
1/8" sheet across bottom
1/16 ply
"Mighty Midget" servo
3/16" sheet let in.
20 s.w.g. alum. cover for battery box.
10 s.w.g. dural U/C. 7 1/4" tread.
2" dia. wheels.
1/8" dural engine plate. Screw to bearers.
Rx. batteries
3/16" sheet doubler
1/4" dowels
Servo batteries
Full size wing rib. 18 off. 3/32" sheet.
1/16" ply braces
1/4" x 5/8" or 3/4" L.E.
1/16" sheet top
1/4" x 1/2
3/16" x 3/8"
Chamfer T.E up over this region.
1" x 1/4" T.E.
21 1/4"

Typical of "Galloping Ghost," simple proportional r


e universal joint
sq. hard torque rod
3/16" x 1/4"
1/8" sheet sides
3/16" x 1/2"
3/16" sq.
3/16" x 3/8"
3/16" sheet
1/8" sheet rudder
Linen hinges
6 B.A.
20 s.w.g. stop
20 s.w.g.
16 s.w.g.
Brass bush
1/4" very hard former
1/16" sheet top and bottom.
5"
1"
6 B.A. screws. Cover with nylon to lock
3/16" x 1/2"
1/16" sheet top and bottom of centre.
Stop to give approx 270° movement.
3/16" sq.
1/8" sheet elevator.
1/16" x 5/8" top and bottom.
17 1/4"
Linen hinges
3/16" sheet
3/16" x 1/2"
3/16" x 1/2"
3/16" sheet
F1. -------- 1/4" ply
F2 & 4 ------ 1/4" sheet
F3, 5 & 6 ---- 3/16" sheet
7 3/8"
F6
F5
F5
F6
Formers half size
F3
F4
F2
F1
F4
F3
F2
F1

"Galloper" by C. R. Ralph for 1·5-2·5 c.c. motor

Fig. 13



Theoretical

Practical

Flying

Each system has its own technique; manual pulse can be flown by beginners in spite of the apparently unstable set-up. Use a smaller rudder and launch the model in a slight right bank. The model will now start to turn left, signal until it straightens out. . . . Release the button immediately and wait until it just starts to turn left again, give another push on the button to correct it. It's much easier than it sounds, all you are doing is to correct a natural left turn. This system is used in many slope soarers and has brought home the "hardware" on numerous occasions.

Rudder only pulse is a smooth way to fly, position the stick for neutral and launch. You will soon find where flying neutral has to be so brace your hand against the Tx. case and gently "squeeze" the stick over to apply a turn. Use plenty of stick to start the turn, then as soon as the model banks ease back nearly to neutral quickly and hold it there. If the turn is still too tight "squeeze" in some opposite rudder. Remember that with rudder only models, tight turns loose height; you will have to kill the zoom by applying opposite rudder just like any other model with limited controls.

Galloping Ghost models require quick reaction until you are used to the technique. Only a vague indication of neutral is possible to discern by looking at the model so a take-off is probably the safest method. Steer the model once the tail is up and build up a good speed before easing the stick back. If the stick is almost fully back to keep the model level, and there is no rate trim on the pulser, it would be necessary to adjust the linkage on the model. Once the model has gained height you will find that as the stick is moved over for a turn a little up elevator comes in automatically, this is due to mechanical interaction in the linkage and is a slight advantage, ease the stick back a little and reduce the amount of rudder control. The model should now be turning without loosing height. To recover from the turn give opposite rudder and push the stick forwards slightly as you do so, returning the stick to neutral or to such a position where the model assumes the desired attitude. The flying neutral may not coincide with the stick neutral and some modellers do not have a centring spring on the stick for this reason but we feel that a light spring serves to indicate how much stick movement is left when executing a tight manoeuvre. If you watch a Galloping Ghost pilot you will see that he moves the control stick in an uneven "figure eight" this is a smooth interpretation of the turn procedure just described.

It is almost impossible to do bunts with Galloping Ghost as there is insufficient servo power for extra down elevator, but loops, barrel rolls, Immelmans, Cuban 8's and reversals can be achieved with practice. A burst of full or no signal keyed by separate push buttons will either short out the keying circuit or break the pulse circuit. The effect is to give full up and full left or right. The motor stalls against its stop but apparently without undue battery drain, throwing the model into a barrel roll.

Commercial Equipment

Some time ago Messrs R.C.S. produced a complete relay type Galloping Ghost system, and although this went out of production when the firm changed all their lines to relayless all transistor equipment, some are still in use. We understand that a new British ready made or kit outfit will soon be available by a newcomer to the British trade field. Min-X Radio Inc. market their Pulsemite pulse transmitter to suit their Capri relay Rx. for Galloping Ghost work. Here the Mighty Midget motor is recommended for a servo. C. & S. Electronics have a rudder only pulsed Tx. and rudder only pulser for fitting to their existing single channel Tx. A compatible relayless receiver is the C. & S. Finch which has a double ended output. The C. & S. Septallette magnetic actuator is recommended.

There are three other magnetic actuators, all American; South Western Pou-Voir and Adams.

Make	*Weight*	*Size of model*	*Price*
Septallette	3 oz.	·01-·049 cu. in. power	$6.50
South Western	1¾ oz.	·01-·049 cu. in. power	$5.95
Pou-Voir	5⅝ oz.	½A	$6.50
Adams	1½ oz.	½A	$6.95

Ted Strader's Go-ac, price $14.95, is a device built round a Mighty Midget motor for use as a Galloping Ghost or rudder only with trim elevator or trim engine control. It weighs 2½ oz. and will provide enough power for 3·5 c.c. powered aircraft. Relay type receivers are recommended. The same firm has a "G.G. coupler," this is a set of finished wire parts, couplings and bearings for a Galloping Ghost linkage, price $1.

For builders of pulsers, Ace R/C advertise a "Protroll" control stick kit. This is a solid looking assembly with centring springs designed to be fitted to pots provided by the builder. Rudder only type is $3, dual types $4.95. Complete pulser kits are also marketed; the Phelps pulser has a 70–30 mark/space change (although rate is not quoted) and costs $28.95. The Shows R/O pulsers cost $15.95 and gives a fairly high rate mark/space output. Both have relay outputs.

RADIO CONTROL SCALE

BY DENNIS THUMSTON

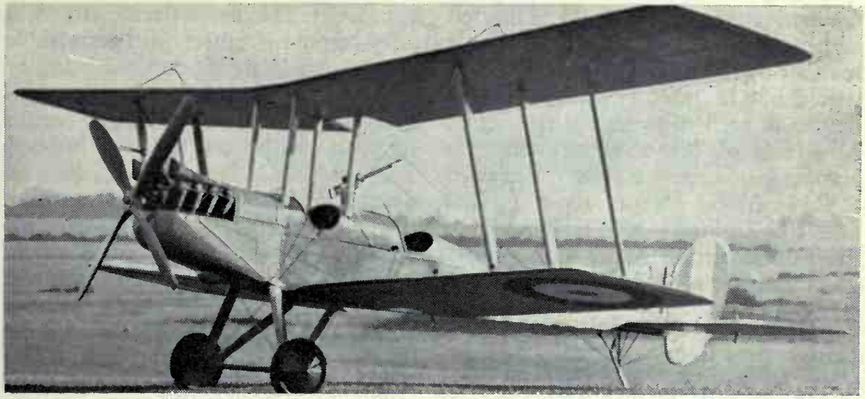
Scale radio control models never fail to attract an enthusiastic audience. Few could fail to admire this magnificent B.E.2. built by the author for Wright single channel equipment.

Perhaps the most fascinating, the most challenging and the most rewarding branch of R/C flying is the radio control of scale models. There is a tremendously wide and varied range of prototypes from which to choose, and the sight of a really accurate replica in full flight and under full control is one of the most satisfying experiences in aeromodelling. With the high standard of reliability of modern radio equipment, models need no longer be regarded as expendable, and the builder should have no qualms about producing a finely detailed model, for there is little fear that the product of his patient and painstaking work will be destroyed in a crash caused by radio failure. Indeed, he can confidently look forward to several seasons of successful and rewarding flying.

In the past, many modellers have tended to avoid scale models for R/C purposes, due to the widely held belief that they are that much more difficult to trim out and fly, and whilst this is perhaps true of the free-flight scale model, the measure of control which is now possible with reliable radio gear takes much of the hazard out of scale flying, especially those first trimming flights!

Let us first consider the choice of a suitable subject—what a tremendous vista opens up before us; from the pre-1914 canvas and wire veterans, through the range of scouts, bombers and reconnaissance aircraft of the First World War, the early air liners, the colourful military aircraft of the inter-war years, the light and ultra-light civil types of the '30s, the racers and record breakers, down to the Spitfires and even Lancasters of the Second World War. Present-day aeroplanes also provide a selection of suitable and colourful subjects, more particularly in the light civil and executive field.

A number of factors will influence the final selection, not the least of which will be the modeller's personal preference for a particular aeroplane, whether it be for its glamour, its colourful appearance, or its attractive outlines. Is it to be an aerobatic machine or a course flyer? Will it be flown chiefly for sport or for competition purposes? Certainly one of the most important considerations will be the type of radio control equipment which the modeller has available, or can afford to install, so that a look at the three main categories of control systems and the types of aircraft most



suitable in each category will be appropriate.

Rudder-only Models

Whilst it is perfectly feasible to fly most scale models successfully using rudder-only control, some subjects are more suitable than others and it is prudent to choose an aircraft with a certain amount of inherent stability. In a model which is marginally stable, though quite happy in calm conditions, we must look for reasonably generous tail areas and a modicum of dihedral, although the latter is not absolutely essential in high-wing or parasol layouts where there is a fair degree of pendulum stability. The faster-flying types will be less critical in the above requirements.

Sub-dividing the various configurations of full-size aircraft which offer suitable rudder-only subjects, we come first of all to the high-wing cabin monoplanes, such as the Pipers, Austers and Cessnas: these are invariably safe subjects which should present little difficulty and provide plenty of scope for really attractive colour schemes. Also eminently suitable are the parasol wing aircraft, for example, the Dart Pup, Sopwith Swallow, Luton Minor and Fokker D.VIII, although it should be borne in mind that many of the types in this category are slow flyers and will not make much headway in a wind.

Most single-engined biplanes make admirable rudder-only subjects, the field being particularly rich in the World War I period. For example, the Avro 504k, R.E.8, B.E.2c and 2e, the Sopwith Pup and 1½-Strutter, De Havilland 4, 5, 6 and 9, Albatros C.I, Junkers J.1 and Rumpler C.IV spring readily to mind. Other biplanes which provide suitable material include the D.H.18 and 34 (both colourful early airliners), the Fox Moth, Hornet Moth and Tiger Moth, the Bristol Bulldog, Gloster Gladiator, Avro Commodore and others too numerous to mention.

There is an interesting selection of mid-wing and shoulder-wing types including the Fokker Eindekker, the Antionette, the Rumpler Taube, the Bleriot and Bristol Monoplanes, the Comper Swift and the Cosmic Wind, all of which would make successful prototypes.

Low-wing types are usually more tricky to fly on single-channel, but the more adventurous spirit need not be deterred by this, for it is quite possible to fly even a Spitfire on rudder-only, although the range of aerobatic manoeuvres would be limited and could not be executed in a realistic manner. Further, the undercarriage would not be retractable, so that the degree of realism would be restricted. More suitable low-wing types include aeroplanes such as the Fairchild P.T.19, Moth Minor, Ryan P.T.20 and the Chilton D.W.1. These are fixed undercarriage types with a fairly good measure of stability.

Single-Channel Models with Compound Escapement

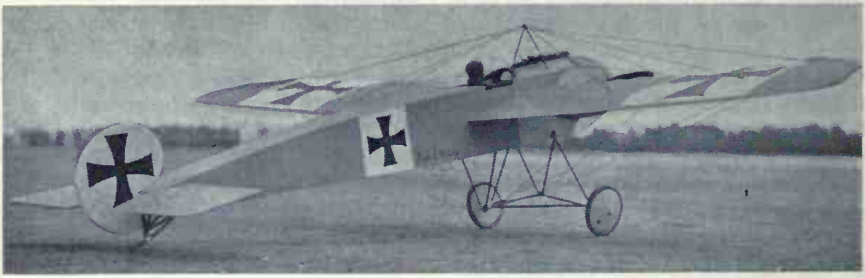
The next step from rudder-only control consists of the use of a compound escapement or actuator operated from a single-channel receiver and giving, in addition to selective rudder control, motor and perhaps elevator control. Aircraft types suitable for this category need to be of a fairly forgiving nature, since this method of control, particularly if elevators are utilised, is not simple to operate and a missed or wrong signal caused through a mistake in pulsing could, at a crucial moment spell disaster. For this reason a fairly stable model is required so that much the same considerations apply here as in the above section dealing with rudder-only models.

Multi-Channel Models

With multi-channel control, the choice of subject is virtually unlimited and will depend entirely upon the modeller's whim, his building experience and flying ability—and his approach! He may decide upon a fully-aerobatic fighter with retractable undercarriage, a four-engined Handley Page Hannibal with working navigation lights, or a crop-dusting Auster Agricola with controllable hopper. For in R/C scale, multi-channel flying does not necessarily mean flying the F.A.I. aerobatic schedule with a B.E.2c—the radio control system is merely a means to an end, the end being to fly the model in a manner which simulates as nearly as possible its full-size counterpart; thus, apart from aerobatic flying, multi-channel makes it possible to fly subjects which would otherwise be just pipe-dreams.

For example, multi-engined aircraft of all types are now fully practicable propositions, provided that the modeller is prepared to accept the chore of starting and synchronising up to four, or even six, motors. An engine failure in the air can be dealt with either by application of rudder trim, or by throttling back and coming in for an emergency landing. Whilst discussing multi-engined types, there are a number of tri-motored aeroplanes, such as the Junkers 52/3m, the Fokker F.VII/3m, the Avro Ten, and the Armstrong Whitworth Argosy (1926 version), which make attractive subjects for multi- or single-channel. These can be flown on one central

The author's single channel Fokker E.III displays meticulous attention to rigging and undercarriage detail. Flown to first place in at least one open rudder only competition.



Sterling Kits' Fairchild P.T.19 spans 45 in. and is suitable for 1·5 to 2·5 c.c. motors. Flies well on single channel radio equipment.

engine, using free-wheeling propellers on the outer nacelles, and though this is perhaps cheating a little, it may be justified on the grounds of simplicity of operation without any great sacrifice in realism.

The fast low-wing types with little dihedral are eminently suitable subjects, and models of this type have, in fact, come very much into their own, especially with experienced multi flyers, since the design requirements and flying characteristics of aircraft like the Mustang, Spitfire and Airacobra closely resemble those of the functional aerobatic model. There is a considerable challenge in the perfecting of aerobatic manoeuvres performed as nearly as possible in the manner of the full-sized aeroplane—this is even more of a challenge when flying a multi-equipped model of a slow-flying biplane, such as the Stampe SV.4B, the Bucker Jungmeister or the Tiger Moth, where the model must really be flown through the manoeuvres, without the same emphasis on speed and power.

Multi control also enables the scale enthusiast to tackle an aircraft featuring a retractable undercarriage—indeed the ardent scale modeller would hardly choose one of these types as his subject unless he were prepared to incorporate retractable landing gear. Suitable commercial units are available, or a simple gear train driven by an electric motor can be installed in the fuselage with suitable linkages to the undercarriage.

Other applications of multi control include bomb dropping, with working bomb-bay doors where applicable, parachute dropping, flap operation, coloured smoke trails (perhaps with a sky-writing version of the S.E.5a as used by Major Savage in 1922) and wheel brakes for ground handling.

In multi, therefore, the sky is indeed the limit, and the choice is yours, but a timely word of warning to the neophyte—let ambition be tempered with discretion. Choose a prototype with a measure of automatic stability for your first multi venture, and make that twelve-channel, rocket-firing Mosquito your second model!

Before leaving this discussion on the selection of the subject, there are a few general considerations which are applicable to all types. If it is the intention to take the model off from the ground—and not all modellers have suitable facilities for this—then the undercarriage position is important. Beware of those aircraft, the Nieuport 17 for example, which, in order to provide ground clearance for the propeller, had a very tall forward-placed undercarriage. These types will tend to swing rather badly on take-off. Generally speaking, a low undercarriage which is only slightly ahead of the C.G. gives the best take-off characteristics, whilst the ideal, of course, is the tricycle type of landing gear. Another point to be wary of—if an aircraft with a large radial cowl is chosen, care should be taken to ensure that the cowl is not of such a diameter that it will render the airscrew ineffective.

Whatever you may decide upon, try to get out of the rut; choose something a little different, for there is so much more satisfaction to be gained from the building and flying of a unique model.

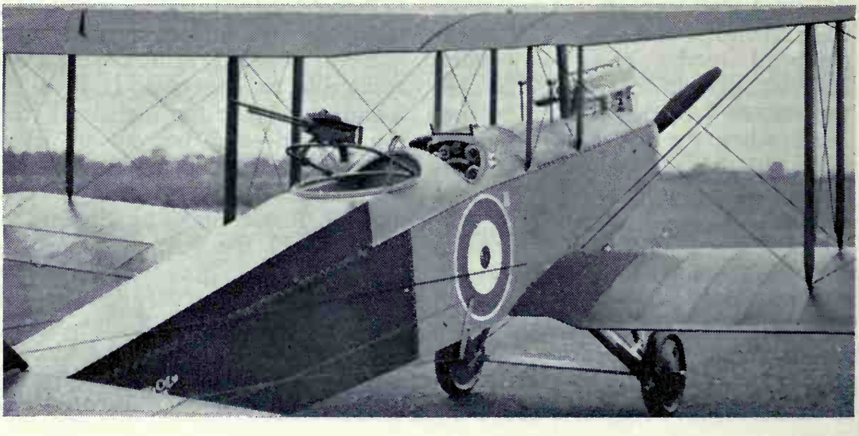
Choice of Equipment

For the rudder-only model, any of the lightweight single-channel relayless tone receivers, coupled with a reliable escapement, is ideal: there is virtually no weight problem, since most of these receivers operate on a 3V supply, which also powers the escapement. If the receiver will operate satisfactorily from a DEAC cell, so much the better: a charging point can be incorporated, thus avoiding the necessity for resoldering new batteries, since limitations imposed by scale requirements may make access to them difficult. The escapement may be of the sequential or selective rubber driven variety according to individual preference—in the writer's view, the simple click-clack type, such as the Elmic Conquest, is the most satisfactory. All up weight of this type of gear need not exceed 5 oz. and may be as little as 2 oz.; thus it may be installed equally as well in a lightweight model of 30 in. span as in a 6 ft. model weighing several pounds.

Mention might be made here of a device which can be used to advantage on models with little or no dihedral—this is the use of coupled ailerons and rudder (C.A.R.), operated simultaneously by a motorised actuator either on single- or two-channel, a relay receiver normally being required. Better lateral control and more realistic turns are achieved by this means.

Turning to the compound type of actuators used in conjunction with single-channel radio, the chief benefit lies in the provision of throttle control, which adds materially to the realism of a flying scale model: dummy approaches, low passes and landings with motor ticking over being very pretty to watch. Or after using full power for take-off, the engine can be

The author's 1965 British Nationals Scale winning D.H.9, even dropped bombs. Uses multi radio equipment and spans 6 ft. Meticulously detailed.



Well, is it real or not? Actually it is a 72 in. span model by Peter Anderson, Newark, who equipped this Cessna 172 with home-built multi radio.

cut back to cruising revolutions. However, the "cascading" of escapements in order to obtain elevator control is not recommended for use with scale models unless the operator is very experienced in the use of this type of equipment. A more suitable actuator for this purpose would be the four position self-neutralising motorised variety, such as the Cobb Micro-4—an added advantage of the motorised compound actuator is that the speed of pulsing required remains constant, whilst the rubber-driven compound escapement may be affected by loss of turns. The main point to be borne in mind is that compound radio cannot be considered as an alternative to multi-channel and should only be installed in the slower, stable type of scale models.

In the field of multi control equipment, the modeller will first have to decide how many channels he will need for the controls he has in mind: a fairly stable subject may only require rudder, engine and elevator controls, plus perhaps a channel or two for special effects, such as bomb dropping. A fully aerobatic model will require "full house," *i.e.* ten channels, or even twelve if flaps or special effects are to be incorporated, although the latter could be operated from the elevator trim servo; for example, full "up" trim may be used to release a parachute by fitting a secondary linkage.

Conventional reed equipment is entirely suitable and a wide range of commercial products is available for the modeller's choice: again, it should be stressed that, even if it costs more, proven reliability should be the keyword. Next, the question arises, superhet or super-regenerative? Apart from its comparative immunity from interference, superhet scores for scale by virtue of the possibilities it opens up for formation flying or mock dogfights with other scale models. Then, shall we choose a relay or relayless receiver? With reed equipment, relayless is preferable since, when we come to furnish the cockpit or cabin of the model, space is at a premium, and the relayless receiver is more compact.

There is, however, another type of multi equipment which, although employing relays, is very compact indeed—this is the plug together, tuned filter type exemplified by Grundig. Another merit of this type of gear is that it is easily transferable from model to model, and can be built up from two to eight, or ten channels according to requirements. Wiring up

9
G-ADNL
G-A
DNL

is simplified, consisting of a ready made harness. The servos are very small, which is an important consideration not only when furnishing the cockpit, but also when fitting an aileron servo in a biplane's centre section.

Last, but by no means least, we come to simultaneous proportional gear which, with stick control simulating full-size practice, probably represents the ultimate in radio control systems and with its use, even the most difficult scale subjects can be tackled. Proportional control will also result in smoother, more realistic manoeuvres. However, the skill of the pilot is of paramount importance, and proficiency in handling this type of equipment should be gained before installing it in a scale model.

Choice of Engine

Before turning to the preparation of the plans, it is as well to consider the type of engine which will be fitted, since the design of the cowling and bearers will depend on the external geometry of the engine selected.

60 in. span. Miles Sparrowhawk by Dennis Bryant is a fine replica of one of the sleek monoplanes of yesteryear. Equipped with F & M 10 channel radio and Merco 61 motor.

Perhaps the first consideration will be the amount of power required, bearing in mind the flying speed of the subject—one would not expect a scale Supermarine S6B to limp slowly across the sky, or a model Luton Minor to fly at 60 m.p.h.: therefore, relate the power to the subject. It is usually wiser to tend to overpower rather than underpower, for it is then possible to slow down the motor with a larger propeller if necessary or, if throttle control is fitted, to cut down the revs after take-off.

For models up to about 60 in. span, either diesel or glowplug motors are suitable, the decision depending largely on personal preference. Both types have their advantages and disadvantages—the diesel is rather messy in operation, but does not necessitate the same degree of fuel proofing as the glow, a point to be considered when a semi-matt finish is required. Again, the diesel will usually swing a fairly large, near-scale propeller, with a realistic engine note, but the glow motor creates less vibration and has better throttle control characteristics. A fully cowled glowplug motor may necessitate the provision of an external power socket for the accumulator leads, and will also incur greater cooling and heat-insulation problems.

The large multi-channel subject, particularly the fast aerobatic type, will invariably demand a glow motor, and for scale use, special regard should be made to the idling performance.

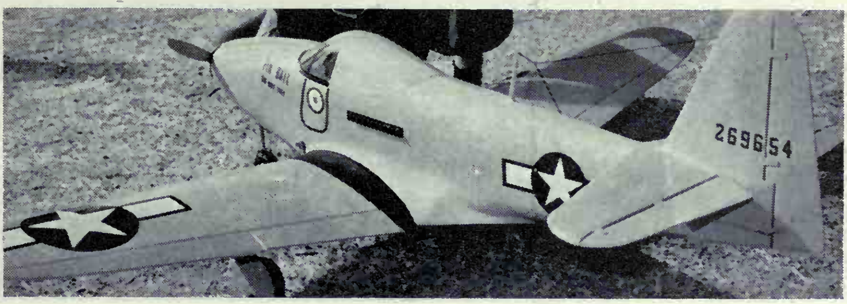
Specific aircraft may impose special requirements; for example, a radial cowled model engine will be easier to finger-choke for starting if it has front-rotary rather than rear induction, whilst the opposite may apply with an "in-line" type of cowling. A slender pointed-nosed aircraft poses special problems. One of the first points which the serious scale enthusiast will consider will be how to hide, or disguise, the model engine—no scale model worthy of the description will sport a large cylinder head protruding from an otherwise streamlined nose. This problem is not insurmountable; an extension shaft fitted to an inverted engine will provide the solution. For those defeatists who say—ah, an inverted glowplug engine is difficult to start, the remedy is equally simple; a cradle in which the model can rest inverted whilst the motor is started restores the status quo! Another approach to this problem lies in the use of an engine which has been specially designed for installation in the streamlined type of cowling, viz., the Aero 35.

Preparing the Plans

Accurate three-view drawings, from which to prepare working plans, are essential and these may be obtained from a variety of sources, such as the aeromodelling magazines, contemporary issues of *Flight* (which should be available at the local Reference Library, who will usually supply a photostatic copy at a nominal charge), or from the Public Relations Officer of the actual manufacturers. Copies of original working drawings of most of the Royal Aircraft Factory aeroplanes can be supplied by the Ministry of Aviation.

Photographs of the actual aircraft to be modelled should also be studied, not only to verify the accuracy of the drawings, which may need some slight corrections, but also to obtain those scale details and markings which are the hallmarks of a good model. The photographic libraries of *Flight* or the Imperial War Museum will provide fruitful sources, whilst members of "Air Britain" have their own

This Bell P-63 Kingcobra by Max Hester, won the Scale Championship at the 1964 U.S. Nationals. Uses 10 channel radio and Fox ·59 motor.



reference service at their disposal.

The size of the model will have been determined to a certain extent by the type of equipment to be installed, but the optimum span will be, as a general rule, between 40 and 72 in. Anything below 40 in. is usually at the mercy of the elements and stability requirements may become more critical. The larger models are the more impressive and scale speeds tend to be more realistic, but once the span exceeds the 6 ft. mark, weight becomes a problem and heavy landings are apt to be more damaging.

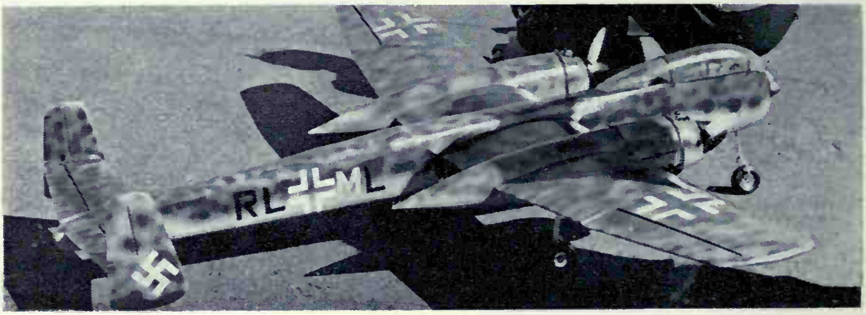
There are several means by which the drawings may be scaled up, but a full discussion is beyond the scope of this chapter. The more common methods are: Multiplied Measurement, Two Scale Rule and Photographic Enlargement. These and other systems are fully described in *Flying Scale Models*, by R. G. Moulton, a valuable source of reference for the scale enthusiast.

Construction and Design

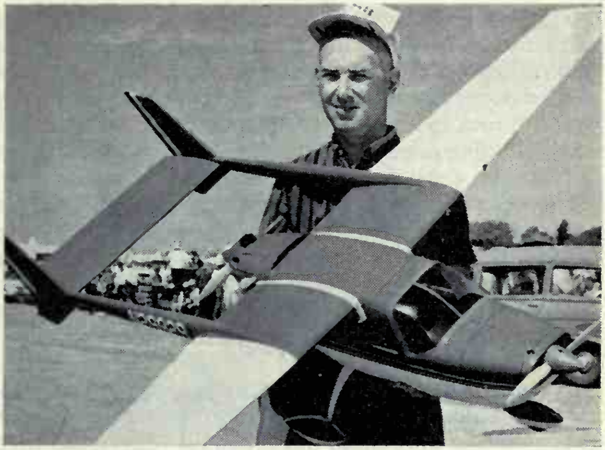
Now to constructional methods and design techniques. In order to achieve a high degree of realism, the original type of construction should be simulated as nearly as possible. For example, the box girder fuselage of early biplanes is easily reproduced, using spruce longerons and spacers in scale positions; or for greater strength, sheet sides may be used, with dummy longerons and spacers of true scale width superimposed upon them—this gives a most realistic appearance after the covering has been applied. The fully streamlined stringered fuselage may also be built around a basic box structure, though where less strength is required, for instance, in a small single-channel model, the crutch method of construction is satisfactory. The monocoque type of fuselage will naturally entail a planked structure.

Wing design, too, should simulate the full-size, at least as far as external appearances are concerned. If the outline of the wing ribs is visible on the full-size wing, then rib for rib construction is called for, not forgetting leading edge riblets if present, as on the Avro 504 or Tiger Moth. Where leading edges were sheeted, this too should be reproduced, whilst the plywood or metal-covered wing of the original will need to be sheeted with a soft grade of balsa in the model version.

The airfoil section of the full-sized aeroplane is an integral part of the aircraft's character and any great deviation from it in the model will



Twin engined Heinkel 218 by David Walker, used F & M 10 channel radio and two K & B 45 motors. Looped and rolled successfully.



The easy way out with twin powerplants, a 76 in. span push-pull Cessna Airmaster by J. Thompson, U.S.A., used two Veco 45 motors and Orbit radio.

invariably result in a semi-scale appearance. A thin, undercambered wing might have to be thickened slightly in order to accommodate the necessary depth of spar, but most other sections will require little change from the original. Possible exceptions are the near-symmetrical airfoils which, although suitable for a fast-flying model with multi controls, may permissibly be changed for Clark Y on a slower-flying rudder-only type. Wing spars should be of spruce on all but the smallest models.

One of the major problems in design is the method of attaching the wings to the fuselage without the use of unsightly rubber bands, while still retaining the strength required for an R/C model—particularly an aerobatic type. With a biplane, this can perhaps be best achieved by the use of a rigid cabane and centre section structure, with dural tongues protruding from the centre section and fuselage sides, locating in plywood boxes in the wing roots. Additional strength can then be acquired by the use of functional flying wires. High-wing, mid-wing and low-wing monoplane types may also use the tongue and box method, although an unbraced low-wing aerobatic model could incorporate a one-piece wing attached by the carpet-snap method without too much loss of realism.

If the true appearance of the aircraft is to be preserved, the scale dihedral angle should also be adhered to—this is no problem with multi-equipped models, whilst for rudder-only types, generous wash-out on the wingtips will largely compensate for any lack of dihedral.

The same constructional considerations mentioned above in reference to wing design also apply to the empennage. This may be a fixture or a removable unit, but if the latter, external rubber bands should again be avoided.

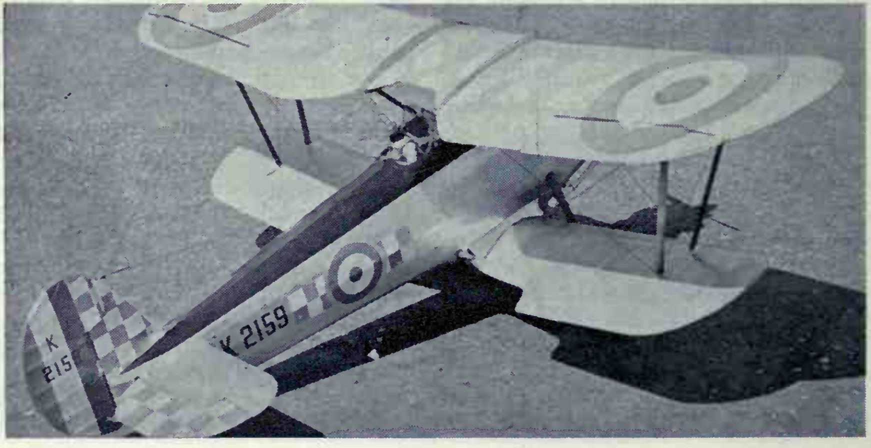
For strength and durability, nylon covering for the whole airframe is an absolute must on all but the smaller models—it can be most annoying to have a lovingly hand-painted roundel, or other item of decor, ruined by a simple tissue tear!

Control surfaces should be of scale dimensions, even on a rudder-only model, although the amount of movement will need to be limited in this instance. A suitable method of control linkage for escapement-operated rudder-only models is that suggested by the late P. E. Norman, whereby the wire extension from the torque-rod, protruding from the sternpost, is angled upwards at about 45 degrees and can rock in a hollow compartment in the leading edge of the rudder. The linkage is thus completely hidden. Servo-operated controls should employ the usual push-rod method, but where wing halves are detachable, aileron operation can be effected by rotary torque-rods in the wings, keying into a rotatable tube in the fuselage.

The final effect will be determined by the amount of scale detail incorporated in the model, but it should be remembered that a small model is apt to develop that "Christmas-tree" look if too much detail is applied, whilst a larger model can take and indeed, will demand, very much more. For competition purposes, the model will be judged not only on its flying performance, but also for its fidelity to scale and quality of workmanship. This will include all apsects of the model, embracing wings, fuselage, tail unit, undercarriage and wheels (which will usually need to be specially built), struts and bracing, cockpit or cabin interior details (not forgetting the pilot), glazing, armament, finish (including markings and decor), engine cowling, dummy engine and scale propeller, although it is not usual to expect the latter to be used for flying. Additional points may be gained for any ingenuity displayed in construction. The contestant will be required to produce proof of scale, consisting of three-view drawings and photographs of the original aircraft, together with any other material used in preparing the plans.

Flying

The art of R/C scale flying, whether for sport or competition purposes, is easily defined—it simply means flying the model in such a way as to simulate the performance in the air of the full-size machine. The first and perhaps the most important aspect is, of course, the speed of the model and this has been dealt with previously in the discussion on the choice of suitable power. Then, the smoothness of flight: over-control should be avoided and the range of movement of the control



This Bristol Bulldog is the work of Dr. Henley, who installed Orbit 10 channel radio and a Merco 61 Powerplant. 63 in. span model flies well.

The D.H. Tiger Moth has long been a favourite with scale enthusiasts. This model is the work of Jack Morton. Radio is Min-X 10 channel and the upright motor is a McCoy 60.

surfaces should be limited so that violent response to signals is avoided.

The "sit" of the aircraft in the air will be important for some types—for instance, the Whitley had a distinctive nose-down attitude when in flight, and this could be achieved by the use of suitable rigging angles at the design stage.

Landing approaches can add a considerable touch of realism if full-size practice is adopted—the habit should be cultivated of always performing a rectangular circuit and approach before landing. Not only is this good practice for competitive flying, it also simplifies judgment of height and distance at all times when coming in for a spot landing. Where applicable, wheels will be lowered on the downwind leg and flaps on the final crosswind leg or approach.

For competition flying, the schedule usually consists of an optional take-off—seaplanes may use a dolly—followed by a course flying demonstration and a choice of perhaps three manoeuvres to be nominated by the contestant from a given list of various aerobatic manoeuvres and special effects. Realism in the air is judged, also the circuit and approach, and the quality and precision of landing. In the past there has been a regrettable tendency for the flying schedule to be heavily weighted in favour of the aerobatic model, but there is a growing realisation that the range of optional manoeuvres from which to choose should be increased, perhaps by the inclusion of further course flying figures, so that the non-aerobatic types will have an equal scoring potential.

It has only been possible in this chapter to touch on the broader aspects of radio control scale, for it will be realised that each aeroplane is virtually a subject in itself, but it is hoped that this short treatise will help to encourage an ever-increasing following in this fascinating art.

SECRETS OF R/C ENGINES

HOW TO GET THE BEST FROM YOUR R/C POWERPLANT

There is no magic formula which applied to the use of a given engine will ensure an optimum result. Rather there is a series of factors all of which must be taken into account if the best performance is to be obtained.

For the modern R/C Glowplug multi-speed unit these are:

1. The mechanical condition of the engine.
2. The glowplug.
3. The fuel.
4. The fuel system.
5. The prop.
6. The settings.

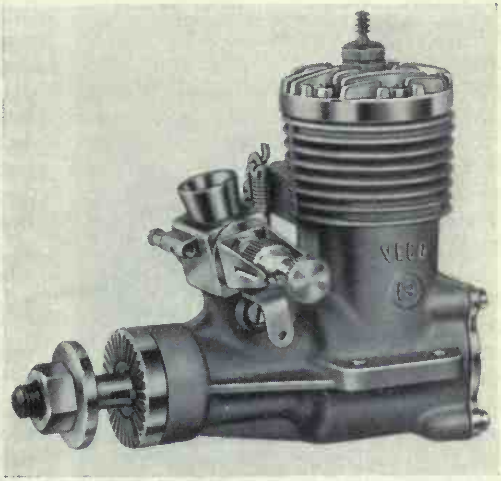
Without any conscious effort on the part of the writer these have almost certainly been put in their order of importance so we will deal with them in that sequence.

1. Engine Condition

The mechanical condition of the engine is obviously of paramount importance, but its significance goes way beyond merely stating that an engine must be mechanically sound if it is to perform well.

Take a new engine. The fits will be tight, especially if it is a unit in short series production where each motor is carefully assembled by hand, and the motor will be correspondingly tight to turn over. A new motor in this condition needs to be treated with extra care during the running-in period and will certainly not run as slowly in the closed-throttle position as one that is fully run-in. This is due to the fact that the frictional losses within the engine will absorb more power than in a run-in unit and the engine must be kept running faster to produce that power. In general it is wise to avoid too much slow running with a new unit as this can lead to unsatisfactory running-in and with certain fuels can also lead to the engine becoming coated with the products of incomplete combustion. This "varnishing" of the working parts of an engine will occur at its worst when it is run hot, slow and rich, just the conditions that will inevitably be achieved when trying to run a stiff new unit at "tick-over."

So the first rule for getting your engine into good mechanical condition



Typical of today's throttle equipped engines for R/C is this Veco ·19 displaying a conventional carburettor throttle assembly.

throughout is to run it in correctly.

The running-in process is different for every type of engine. Some require a break-in period of only thirty minutes or so after which they can be put in a model and operated at at least 90% of their full performance level without harm. Others require hours of breaking-in, the worst example in our experience being a motor that did not really free-up until it had had five hours, careful running-in a process that added not less than three pounds ($8.50) to the cost of the engine by the time it was fit for full service.

In general, units with piston rings and ball races on the crankshaft need the minimum of running-in whereas motors with plain main bearings and lapped pistons will require a lengthy break-in that will depend partly on the metallurgical structure of the engine and partly on the tightness of the fits when assembled in the factory.

It is not possible to be too careful in running-in a new unit even when the running-in period is only thirty minutes or so and the following rules should be applied to all glowplug motors:

(*a*) NEVER attempt to operate a new engine at peak revs, *i.e.* NEVER lean the motor right out when new.

(*b*) ALWAYS use a carefully balanced wooden prop for running in and preferably choose one of larger diameter and lower pitch than the working prop recommended for the engine, *e.g.* if the recommended prop is an 11 × 6 run it in a 12 × 4. If it is a 9 × 6, use a 10 × 4 or 10 × 3½. This gives a good flywheel action without an excessive aerodynamic load.

(*c*) ALWAYS run in on a "straight" fuel, *i.e.* one without any additives, if you can. Three parts methanol to one part degummed first pressing castor oil is the answer and recommended oils that meet this specification are Castrol "M" and Baker's A.A.

(*d*) ALWAYS run the engine on the rich side. This ensures adequate lubrication and a reduction in r.p.m. and running temperature. Use between half and full throttle conditions at all times when running-in, avoiding any lengthy periods of running with the throttle closed.

Quality of the glowplug is all important to successful operation of a glow motor. These are Veco plugs. Note idle bar.

(*e*) A good rough guide to setting the needle for running-in is to start the motor rich. As soon as it is running with the plug lead off, close down the needle *slowly* until the motor just breaks into a 2-stroke and *immediately* open up the needle a few notches so that it is just 4-stroking. A new motor should run for hours at this setting without any tendency to seize or pick up.

(*f*) The feel of the engine when the prop is turned over slowly is a good guide to how it is running-in and this should be tried hot and cold frequently during the running-in period. The engine should have good compression hot and cold and should feel smooth right through the rotation of the crankshaft.

As the running-in period approaches its end you will find that the motor can be run leaner without any tendency to pick-up or seize. At this stage you can make your first efforts to adjust the slow running but not before.

With the motor running at its peak, or as near the peak as it will now hold, adjust the needle so that it is just on the rich side of the optimum setting but with the motor maintaining a 2-stroke. This will be about halfway between the setting for maximum revs at a clean 2-stroke and the setting where the motor is just breaking from a 2-stroke into a 4-stroke.

Now close the throttle. If the motor immediately goes into a rich 4-stroke or even an eight stroke DO NOT attempt to adjust the needle but open the air-bleed on the throttle which enables the tick-over mixture to be weakened without upsetting the setting already arrived at for peak revs. As the air-bleed is opened the r.p.m. will rise and this can only be compensated for by closing the throttle barrel by means of the throttle stop screw. (N.B. these adjustments are now practically standard for all large glow engines). Final balancing of the air-bleed and throttle stop, can only be done when the engine is fully freed up and should be done with a tachometer of some sort. A simple and very practical type is the resonance type of tachometer which has the advantage that it is at its most accurate when the vibrating wire is longest, *i.e.* at low r.p.m. A good figure to aim at for a glow engine in the 49–61 class is from 2,400 to 2,600 r.p.m. This figure will give a stable tick-over which will be maintained under most flight conditions where it is needed, as, for example, in consecutive spins. If an attempt is made to reduce the tick-over to as low as 2,000 the engine is quite likely to quit in the air during certain manoeuvres.

When the motor is fully run-in a slower tick-over together with a leaner full-speed setting will be obtainable but not before.

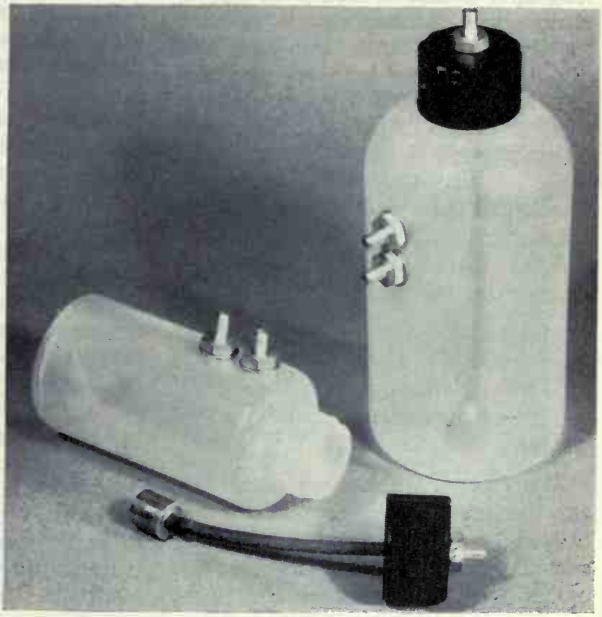
During the break-in period make periodic checks for any developing mechanical faults. Ball races should always feel real smooth when the shaft is turned over by hand. Any "lumpiness" that develops means either pitted ball races or races that have been shrunk too hard into the crankcase. Any engine developing this kind of fault should be returned to the makers for their attention.

Compression, which should always be checked with some thin oil in the bore, should be good but will never feel quite as good with a piston ringed engine as with a lapped piston. There is a good reason for this. Rings do not work efficiently until the motor is turning over fairly fast and at the speed at which the engine can be turned over by hand they do not seal properly. The only true test for compression in a ringed engine is "does it start and run well ?"

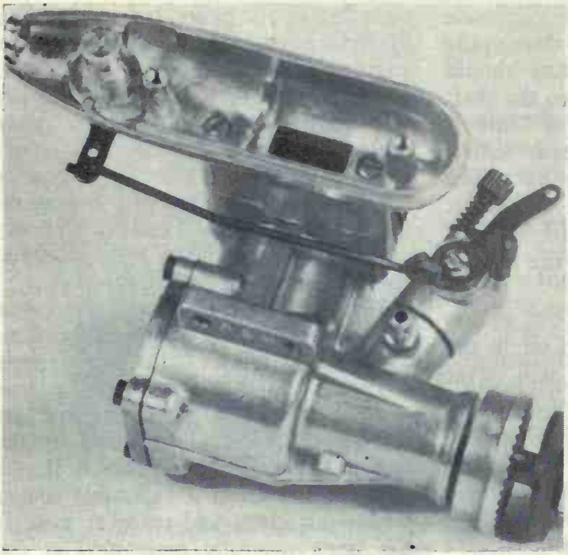
During the break-in period test the tightness of the cylinder head holding downscrews at least twice and while the engine is hot. Do NOT overtighten. Use of a small screwdriver will ensure that undue force is not used. If your motor has Phillips screws buy yourself a small Phillips driver. There is nothing sadder than a fine engine on which the cylinder head and crankcase cover screws have been mangled through using the wrong tool.

Unless you have a very good reason for doing so don't strip your engine down. One knows so-called experts who say that they strip every engine down to clean up the inside and get out all the swarf left inside at the factory. But our experience is that a good engine from a reputable maker comes out clean and ready to run. It has been carefully assembled at the factory and is better left undisturbed.

If you follow these hints you should finish up with an engine that is in sound mechanical condition and ready to perform well in your model.



The polythene bottle "Clunk Tank" is universally employed among R/C'ers today. These "308" tanks have air vents in the top rather than in the cap as is more general.



In the interests of good public relations, a silencer is a most important part of any motor. This O.S. Silencer displays cleaver linkage between carburettor barrel and butterfly valve in expansion chamber.

2. The Glowplug

The Glowplug is often neglected by modellers who just take for granted that it will continue to perform well long after it has, in fact, lived out its useful life. Unhappily it is not possible to lay down any hard and fast rule as to how long any plug will last as they vary considerably in themselves and their useful life is also much affected by their working conditions which vary from engine to engine and even from model to model when fitted with similar power units.

Signs that indicate a plug is no longer at its best are:

(*a*) Poor tick-over and cutting out in the air.
(*b*) Difficult starting.
(*c*) Irregular running (including surging).

Many times when these symptoms are present and the modeller is blaming everything except the plug and may even be considering that the motor itself is nearing the end of its useful life, a complete cure can be effected by putting in five bob's worth of new plug.

If your plug is suspect the only way to check it is to remove it from the head and inspect it. The filament should be clean and bright. If it is black or dark brown it should be discarded. If the element has become physically distorted it is not worth while trying to "winkle out" the spiral with a pin as one has seen attempted so many times. Fit a new one.

Plugs run in inverted engines generally have a shorter life than in upright engines. This is because with the motor inverted when the engine is primed or flooded, drops of liquid fuel will inevitably gather in the plug and on the element. Then when the battery is applied this will be "cooked" off the element leaving it coated with partly burnt castor oil, a condition which is hardly calculated to improve its performance.

Remember that poor starting can as easily be caused by a run-down starting battery as a worn-out plug. A dirty contact between the glowplug clip and the plug or head can also be a source of poor starting and go undetected to baffle the owner. The answer here is to keep the plug and clip clean and the battery well charged. These simple precautions with reasonably frequent inspection of the plug itself should ensure freedom from trouble in this department.

Lastly a note about the choice of the right type of glowplug for your engine. This is really a matter for trial and error. One hears so many contradictory opinions as to whether a given plug suits a certain engine, and modellers are so vehement in expressing diametrically opposed views as to the performances of different plugs in their engines, that one can only recommend a simple "rule of thumb" method. Try them all and select the one that suits your motor in your operating conditions best.

As for the idle bar plug which gives improved slow running characteristics our own view is that it is probably only of value to the modeller who is trying to get a tick-over around 2,000 r.p.m., *i.e.* below the "safe minimum" for his engine. There is always a loss of power in the upper range with an idle bar plug and now that silencers are being used more and more, the double loss from silencer and bar type plug may well be unacceptable.

The fact is that in a well adjusted power unit, an open plug will give a practical r.p.m. range that should fulfill all the demands of the most exacting R/C flier.

In general a 2V plug should be used in any engine over 0·09 cu. in. capacity. The finer elements of the 1·5V plugs are quite allright in smaller engines but will not stand up to the operating conditions in the larger units.

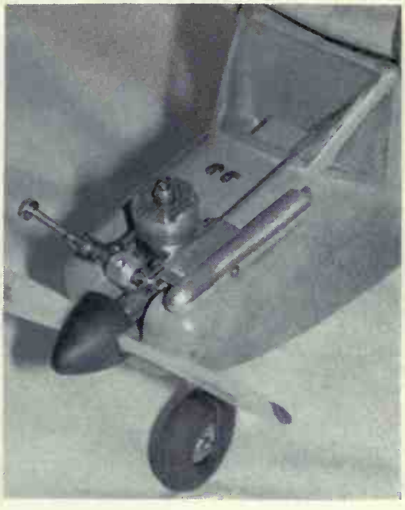
3. Fuel

The most essential qualities for a good fuel are not necessarily contained in its formulation. Rather they are:

(*a*) Use of only the purest and cleanest ingredients.
(*b*) Avoidance of unnecessary and possibly harmful additives.
(*c*) Adequate lubrication.
(*d*) Lowest cost compatible with (*a*) and (*c*) above.

Most engines will run well on one of two very simple formulae: three parts methanol to one part castor oil for running-in; changing to four parts methanol to one part of castor oil when fully run-in.

This is actually more suitable for a ringed and ball-raced motor than for one with plain bearings and a lapped piston. But even a motor of the latter construction can be run with only 20% oil if the fits are right and the engine is free-turning.



Neat installation of Enya ·09 motor in single channel model. Note throttle push rod, running through cockpit.

An engine actually runs cooler with 20% oil than with 25%, as long as its fits are right and there is not excessive internal friction.

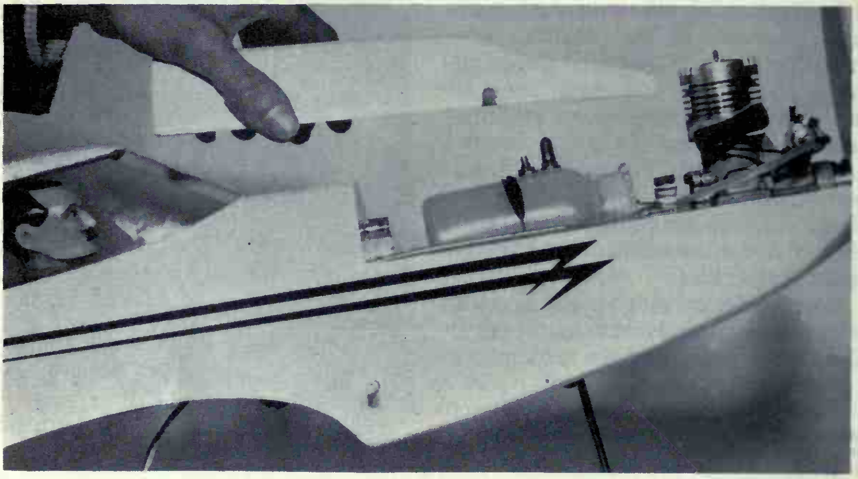
The use of anything from 5% to 10% nitromethane is still popular with some R/C fliers who claim that it improves the running characteristics throughout the range and especially at low r.p.m. On the other hand the addition of small percentages of petrol (gasoline) will also improve the low r.p.m. running by keeping the charge temperature up, at much lower cost and without harming the engine in any way. Between 5% and 10% petrol seems to be the right figure and you would be well advised to try this out in your own engine before finalising your fuel formula. The addition of petrol *can* make the settings slightly more critical at tick-over, but the difference is not sufficient to make the addition not worth while. Once properly adjusted a motor running with a low percentage petrol mix is certainly more stable at the low end.

The Methanol used should be regular power blending methanol which has a very low water content (there is always *some* water in methanol) and which will take castor oil into solution without clouding due to emulsifying. The oil used should be a pure first pressing castor oil which has been degummed and two of the most reliable are Castrol "M" now freely obtainable in Britain and Baker's A.A. in the U.S.A.

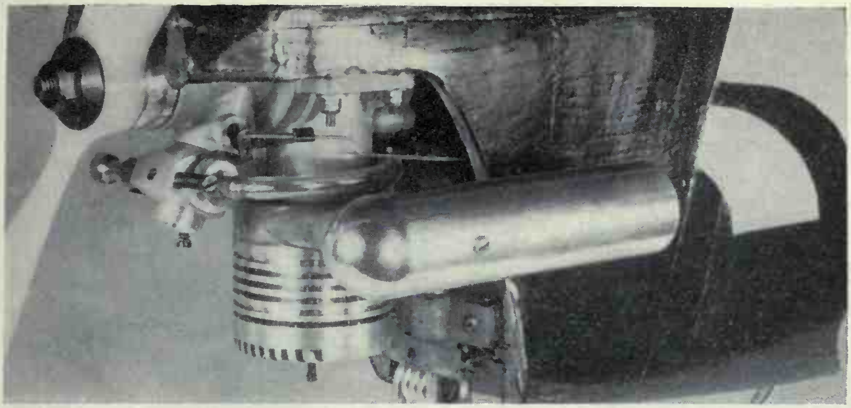
A convenient measure for mixing small quantities of fuel is one of those unbreakable plastic photographic measures used for measuring developer and fixing solutions. They are cheap, accurate, and long-lived. For mixing large quantities, say in gallons, it is only necessary for example to mix a quart of oil to a gallon of methanol to get an accurate 4 to 1 mix.

4. The Fuel System

The best of engines and the best of fuels will not combine to give you a satisfactory result unless the fuel is correctly fed to the engine, and because your motor runs well with the model on the ground it cannot be



Henry J. Nicholl's "Allegro" displays an extremely accessible tank and engine bay, permitting adjustment without digging into a cramped compartment.



Installation detail showing Merco 61 mounted in inverted position. Gee Dee Pike silencer conveniently clears fuselage side.

assumed that it will run equally well throughout the flight pattern.

It must be appreciated that during flight the fuel is subjected to considerable "g" forces during manoeuvres which will cause the motor to run either lean or rich according to the relative positions of the tank and engine and the manoeuvre being performed.

A few simple rules to avoid fuel feed troubles are:

(*a*) Have the tank as close to the engine as possible.

(*b*) Have the level of the surface of the fuel when the tank is full just above and *only* just above the level of the carburettor jet.

(*c*) Always make certain that the fuel is clean. Use a filter between your fuel can and your tank and another in the fuel line between the tank and engine.

(*d*) Keep your carburettor assembly clean at all times. Do not allow stale fuel to dry out in any part of the fuel system and especially in the jet tube in the carb.

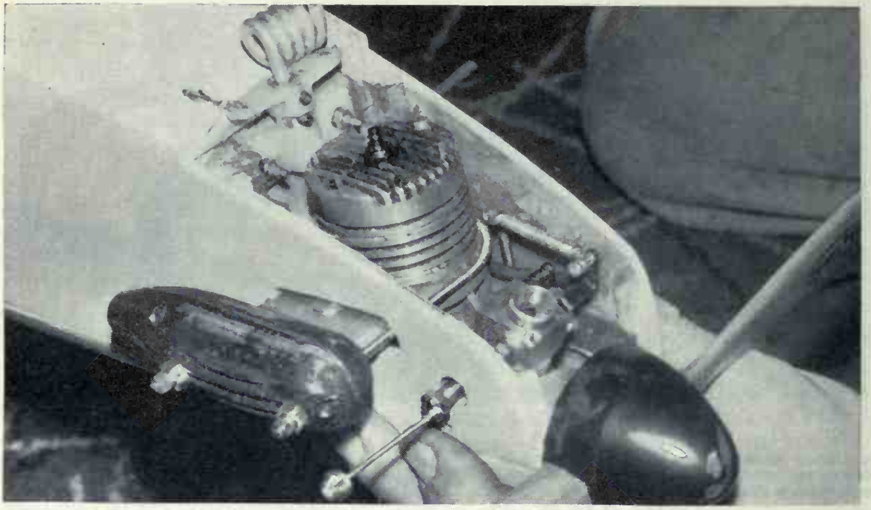
Troubles attributed to a faulty system are often due to incorrect adjustment of the engine carburettor controls. An engine that appears to go sick in either loops or outside loops may not be suffering from a poor fuel feed but merely from too lean a setting. If your motor is set a little on the rich side on the ground loss of power through excessive leaning out in the air will be avoided. A brief excursion into rich running will do far less harm to your flying than an over-lean run. Apart from this, a series of lean runs can actually harm your engine. Most power units today in the larger capacities produce enough power to fly many manoeuvres four-stroking throughout.

The golden rules for the fuel system are, therefore, set it up right, keep it clean, don't run the motor too lean.

5. The Prop

There is nothing to beat a good wooden prop if you are concerned only with performance and smoothness of running. But if you break props then you will almost certainly have recourse to a nylon prop in the interests of economy.

The advantage of a wooden prop is that it is easy to balance accurately. Sandpapering the heavy blade which



can be detected so easily by the silver steel rod on the two knife edges technique (so popular) will produce a prop so well balanced that it will appreciably improve your running. But if you *must* use a nylon prop choose the best balanced one you can buy.

The choice of diameter and pitch now seems to be an accepted standard. For all 45's and 49's an 11 × 6 is normal. For 56's and 61's—a 12 × 6 is the most popular choice with an occasional 11 × 6 where the utmost power is required.

For 29's and 35's a 10 × 6 or 11 × 6 depending on the airframe with an occasional 11 × 5 for the lightly loaded slow flying model in the case of the 35's.

For 19's the choice is inevitably wider because the motor performances in this class are more varied than they are in the larger capacities. A good healthy 19 glow does well on an 8 × 6 or a 9 × 5 and a 15 glow on anything from an 8 × 4 to 9 × 4 or 9 × 5 depending on the airspeed of the airframe to which it is being fitted.

Merco 49 mounted n inverted position. Spring on throttle push rod takes up "fail-safe" over-ride movement on Orbit proportional throttle servo.

It cannot be stressed too highly, however, that whatever prop you use its balance is of paramount importance. An out-of-balance prop will cause vibration that in turn can be the source of serious fuel frothing in the tank and feed tube, with consequent uncertain fuel feed, and also too-rapid wear on the crankshaft bearings of the motor.

Another point to watch for in a nylon prop is blade flexing under its working conditions. If, when the model is on the ground, and the motor is running you can see, at any speed between tick-over and full revs, the blade tips flexing back and forth then the propeller is suspect as this in turn can cause side effects in the running of the engine such as an out-of-balance blade can.

Finally having, by experiment, chosen a prop that gives you a sound performance don't let anybody persuade you to change it. We once saw a

World Championship slip through the fingers of a man who richly deserved to win it because he changed props between rounds and never did get his altered motor settings right. There's a moral there for all of us.

6. The Settings

We have said enough in this chapter under the headings of running-in, the fuel system and so on to convince you that the motor settings are critical to obtaining the optimum performance from your power unit, and that the general rule that gives the greatest benefit is DON'T RUN YOUR MOTOR TOO LEAN.

In fact once the right settings have been obtained for your motor they need hardly be altered.

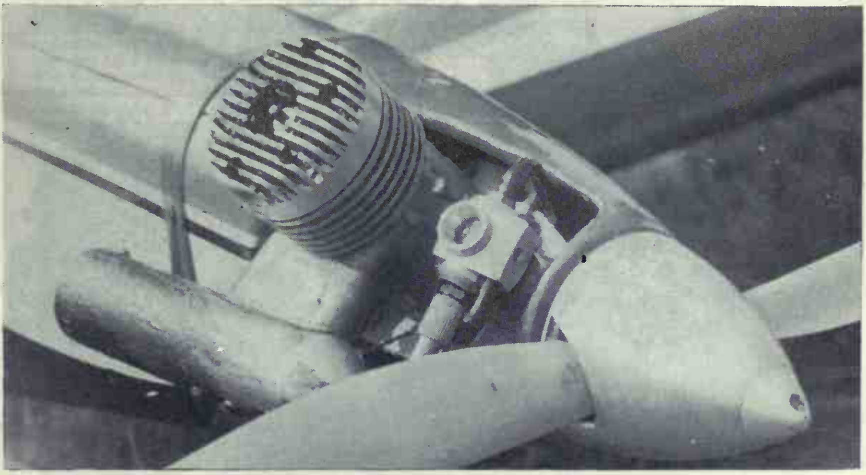
Some motors demand a richer setting for starting than for running-in, in which case it is a rule always to open the needle an exact number of notches from the running setting for starting so that it can be returned to the running setting without fiddling.

With a fully run-in unit the average needle setting seems to be just a few notches on the rich side of the maximum performance setting, *i.e.* on the rich side of a true clean 2-stroke without the motor actually breaking into a 4-stroke.

For the slow-running adjustment, follow the makers' instructions always. They generally know what is best for their own units and their advice should never be ignored. In general never adjust the needle at the low end. Once that setting is correct for high speed running all mixture control adjustments should be by means of the slow running air-bleed control or in the case of the Automix type carb by the selection of the correct helix and needle taper. And don't try to get very slow running, which is of no real practical value, at the expense of a reliable low end in the air.

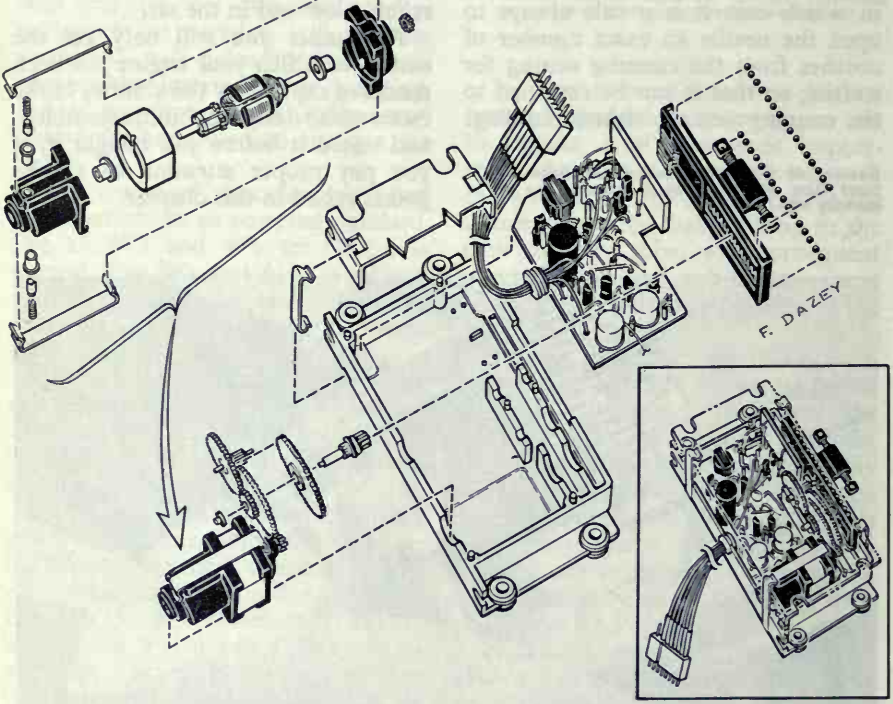
Remember you will only get the results of which your engine has been rendered capable by the abilities of the factory who designed, built, assembled, and tested it before you bought it, if you pay proper attention to all the points raised in this chapter.

Unusual, 45 degree from vertical installation of Super Tigre ·56 permits needle valve to line up correctly with fuel tank.



PROPORTIONAL PICTORIAL

Although series production of a considerable range of proportional equipment is now under way, development in this very new field of radio control continues apace. For this reason, complete tabulated data might lead to possible inaccuracies and it is for this reason that we present this pictorial proportional review.

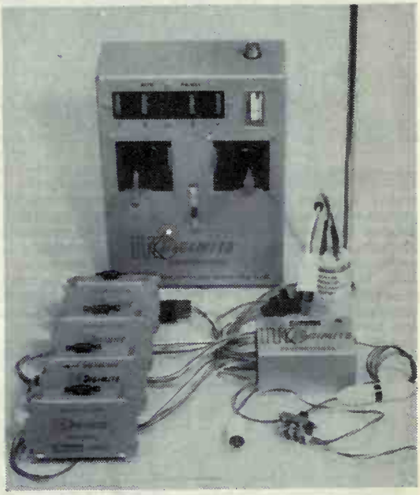


Exploded view of the Bonner Digimite proportional servo showing complete constructional details. Note rack and pinion output with 32 ball bearings. Servo amplifier has 11 transistors.

LOGICTROL
E-K PRODUCTS INC
LOGICTROL

E.K. LOGICTROL (U.S.A.) above: Logictrol is produced in four versions, providing three, four and seven functions respectively. Each is a "digital" type unit and uses Bonner Closed Loop Duramite servos. In the case of the seven channel system there is a choice of either single or twin control stick Tx. layout. The three channel unit, complete with servos, costs $349.50, the Logictrol 4 is $439.50 including batteries and charger and the Logictrol 7, with four servos costs $495.

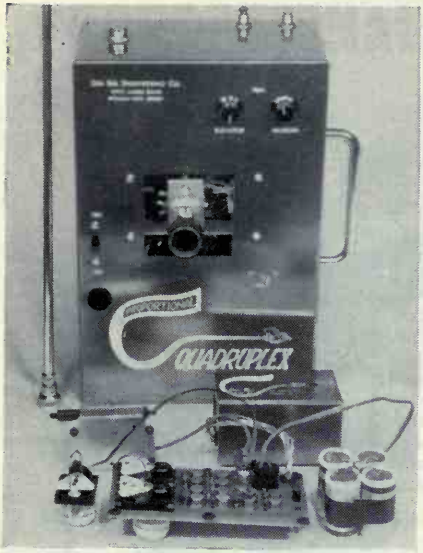
BONNER DIGIMITE (U.S.A.) left: an eight channel digital proportional system, providing the four primary control functions (rudder, elevator, aileron and throttle) plus four auxiliary functions. The two stick Tx., size $8\frac{1}{2} \times 6\frac{1}{4} \times 2\frac{3}{4}$ in. incorporates an integral charger for both Tx. and Rx. battery packs. The twin deck Rx. size $3\frac{1}{16} \times 2\frac{1}{16} \times 1\frac{5}{8}$ in. weighs 5 oz. and has cabled leads with connectors to its Bonner Digimite servos. Each servo measures $3\frac{1}{4} \times 1\frac{3}{4} \times 1\frac{1}{16}$ in., weighs $3\frac{1}{4}$ oz. and has a linear output drive. Airborne installation weight, with four servos in 27 oz. Price in U.S.A. $615.



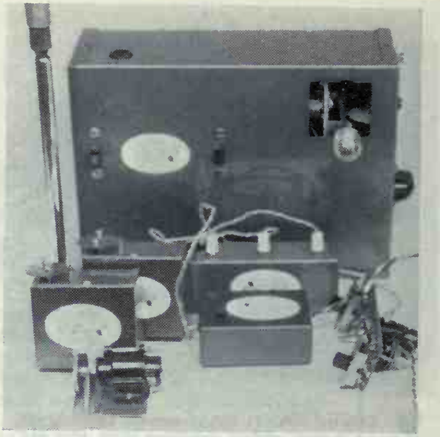
MIN-X PULSEMITE and MINICODER PL (U.S.A.) below: a dual proportional system employing the Min-X Pulsemite single channel pulse transmitter which has a single stick dual axis control column. The Pulsemite 800 (800 c.p.s. tone) operates with the Min-X Capri, relay super-regen receiver and the Pulsemite 1200 (1200 c.p.s. tone) with the Min-X Superhet 1200 relay either receiver then feeding the Min-X Minicoder PL. The Minicoder is the heart of the system, being a transistorised circuit capable of separating pulse width and rate variations and converting them into outputs to drive Bellamatic servos.

MIN-X
MINICODER PL

MIN-X
PULSEMITE 1200
MIN-X
MIN-X
MIN-X

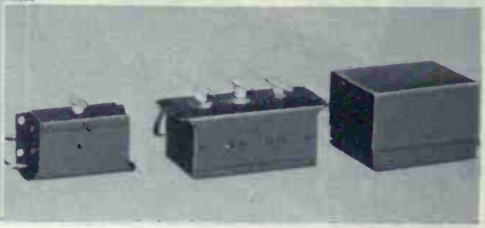


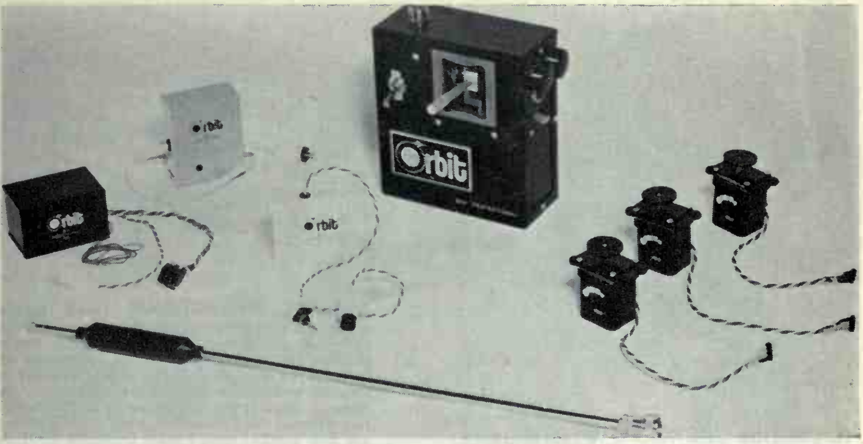
DEE BEE QUADRUPLEX 21 (U.S.A.) above: Quadruplex 21 is a four function analog proportional system. The transmitter, which has a single control column for proportional rudder, elevator and aileron controls, employs a valve circuit driven through a power converter by a battery of 4 AH nickel cadmium cells. The superhet receiver, size 2¼ × 1⅝ × 3⅜ in. is wired direct to a printed circuit installation tray, carrying the transistor servo amplifiers, plus the rudder and elevator servos which like the aileron servo are non-feedback Bellamatics, modified with special centring springs. Airborne installation weight, 21 oz. British price is £270.



GLASS CITY MULTIPLEX (U.S.A.) above: a simple proportional system. The transistorised transmitter employs a mechanical pulser driven by a Mighty Midget motor and has a single control column for the system's two proportional functions, a non-proportional throttle function being commanded from two keying buttons on the side of the Tx. case. The receiver is a single channel relay superhet, with trans-filter I.F. stages. The receiver feeds a Master Decoder network in a separate box comprising a transistorised circuit which detects pulse rate and pulse width signal variations and separates them into two proportional control functions, driving two of the three output relays. The third relay is coupled to a pulse omission detector to switch the progressive throttle control servo. Each servo connects to the Master Decoder via a jack plug. The throttle servo is mounted on an open frame, while the rudder and elevator units are enclosed in metal cases. Being direct pulse servos operating at low pulse rates, the output drives of the rudder and elevator servos display perceptible oscillation, resulting in "wiggling" control surfaces. British price is £98.

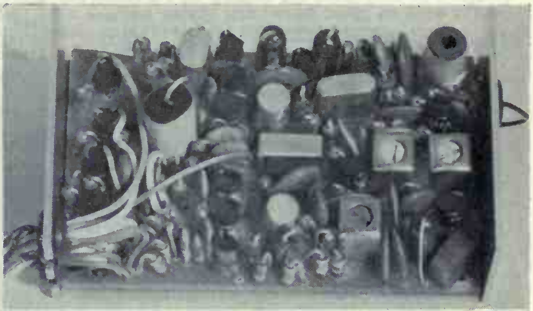
O.S. PROPORTIONAL (Japan) below: although still very much in the development stage, the O.S. Proportional system provides four proportional control functions. The all transistor transmitter has a single control column for rudder, elevator and aileron functions while the throttle control is commanded via separate lever. The superhet receiver is ready wired to the servos, the rudder, elevator and throttle units being housed in a single installation box while the aileron servo is separate.

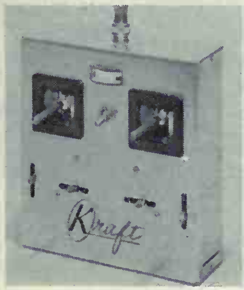


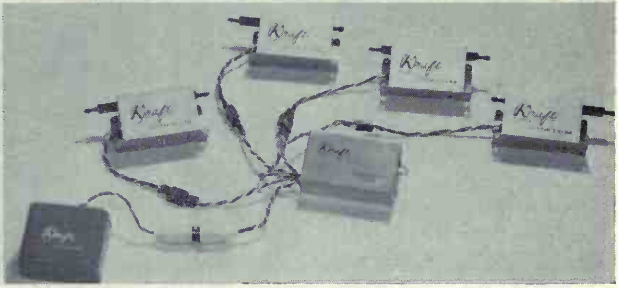


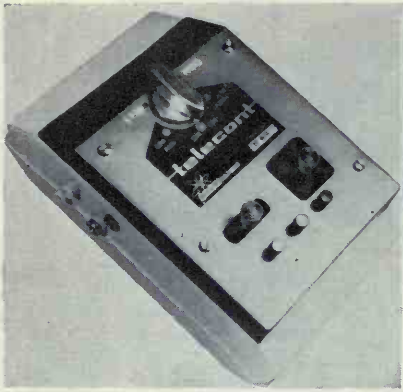
ORBIT 3+1 (U.S.A.) above: the Orbit 3+1 is an analog proportional system providing three independent proportional functions. The transmitter is very small, measuring $5\frac{15}{16} \times 5\frac{3}{8} \times 2\frac{5}{16}$ in. and works off a 9v. dry battery. Two versions are available, one with two control sticks for the elevator and rudder or aileron control and the one illustrated with a single stick. The proportional throttle is commanded from a lever on the side of the case. The receiver, size $2\frac{11}{16} \times 1\frac{11}{16} \times 1\frac{13}{16}$ in., weighs $5\frac{1}{4}$ oz. and employs twin deck construction. This works off a 4.8v. 600 mAH power pack, and is wired to a connector to accept four servos, the fourth servo being wired in parallel with the yaw or roll axis servo to provide coupled rudder and aileron control. Another interesting feature of the Orbit 3+1 takes the coupled aileron and rudder function a stage further, by the use of a micro switch and two resistors. The micro switch is attached to, and actuated by the throttle servo, being used to uncouple and neutralise the rudder servo just below full throttle.

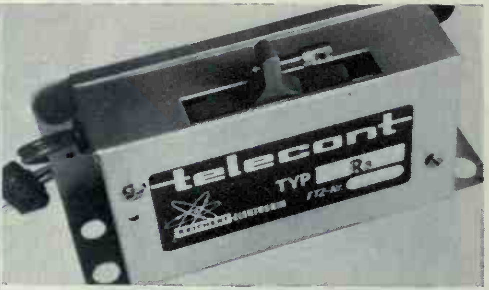
KRAFT KP-4 (U.S.A.) below: a four function digital proportional system. The all transistor transmitter, size $6\frac{7}{8} \times 6\frac{3}{4} \times 2\frac{1}{2}$ in. has two control columns with trim control on each function, the trim on the throttle command permitting servo overtravel to key a micro-switch for an additional, non-proportional auxiliary function such as undercarriage operation if desired. Unlike most of the sophisticated, feedback proportional systems, the Kraft KP-4 has no interference triggered "failsafe" mode, relying instead on high transmitter power to combat interference if encountered. Deletion of the "failsafe" circuitry simplifies the superhet receiver, which is a single deck circuit housed in a box size $2\frac{7}{8} \times 1\frac{3}{4} \times 1$ and weighs 3 oz. The receiver system is supplied completely wired with plug and socket connections to the four proportional servos and 600 mAH power pack. The servos have linear, push-pull output drives. Airborne installation weight is 23 oz. Price in U.S.A., $500.





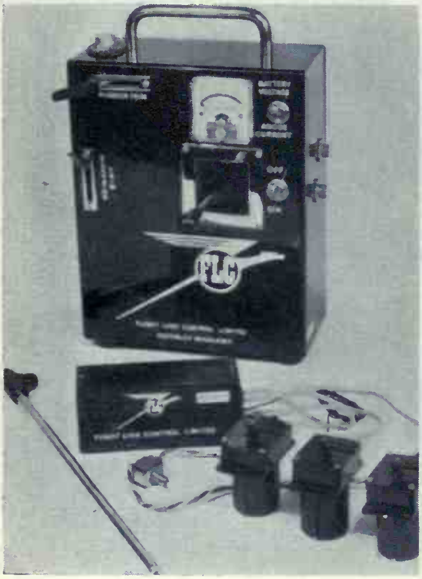




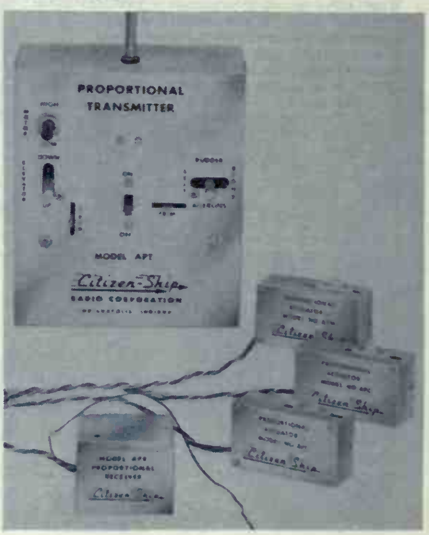


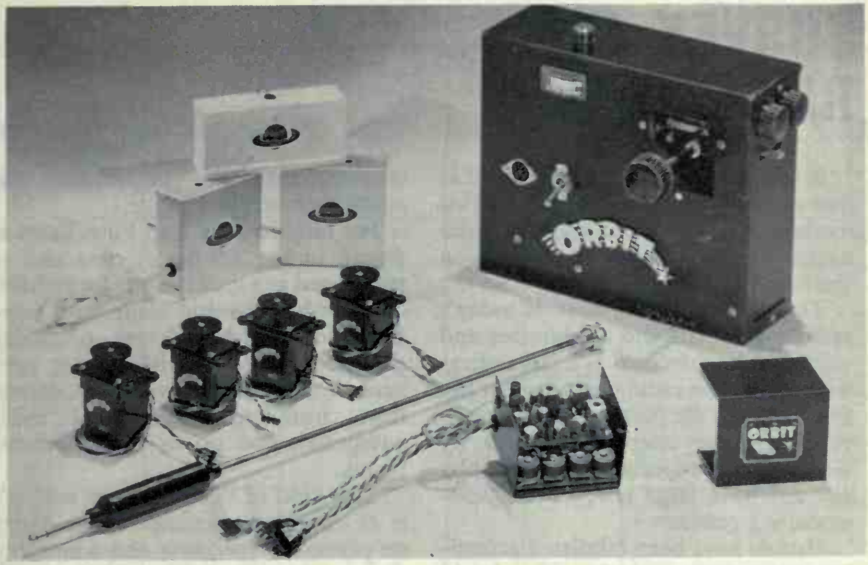
TELECONT PROPORTIONAL (West Germany) above: the Telecont proportional is, at time of writing, not yet in production and information is therefore limited. The transmitter comprises a pulse unit which fits on to the front face of the standard Telecont multi channel transmitter, and as the illustration above displays, employs two control columns. The servo for this system is the Telecont R3, which multi enthusiasts will note displays some Bonner Duramite influence in its shape.

FLIGHT LINK CONTROL SYSTEM (Britain) below: an analog dual proportional control system with additional progressive function which provides proportional elevator and rudder/aileron control with a progression throttle movement. The transmitter, of which only the single control column version illustrated is available, employs valve and transistor circuitry working off a 6v. lantern battery. The all transistor super-regen receiver has three component circuit boards and measures $4 \times 1\frac{5}{8} \times 1\frac{1}{2}$ in. The receiver is wired without plug and socket connectors direct to the three servos, two of which are feedback units. Each servo measures $1\frac{5}{8} \times 1\frac{1}{4} \times 1\frac{3}{4}$ and weighs $2\frac{1}{2}$ oz., but does not incorporate its transistorised amplifier, all three of which are contained in the receiver. Servos and receiver work off a common 7.2v. nickel cadmium battery, bringing the total airborne installation weight to 19 oz. Price £89.



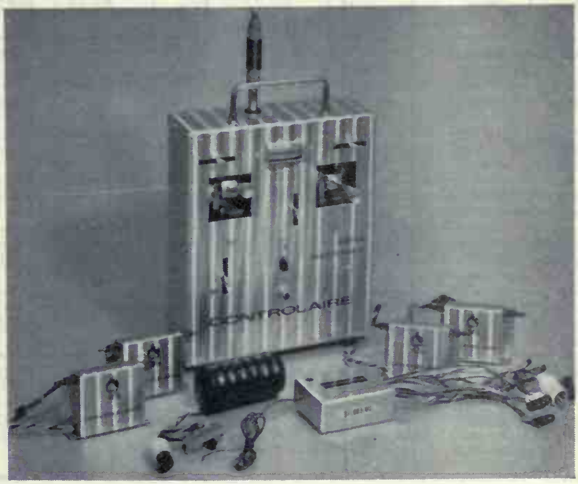
CITIZENSHIP APS (U.S.A.) below: the Citizenship APS is an analog proportional system which provides two proportional control functions for elevator and rudder or aileron control plus a progressive throttle control. The transmitter, size $6\frac{7}{8} \times 5\frac{5}{8} \times 2\frac{3}{4}$ in. has dual control columns for the two proportional controls with a keying lever above the elevator column of the progressive throttle command. The transmitter works off a 9v. dry battery. The 4.8v. superhet receiver which works off a 4.8v. 225 mAH power pack measures only $1\frac{3}{4} \times 1\frac{1}{16} \times 1\frac{11}{16}$ in. and is wired via a connector, a switch and distributor board which also serves the Citizenship servos, permitting an extra servo to be connected in circuit to provide couple rudder and aileron control. The servos each measure $2\frac{3}{8} \times 1\frac{9}{16} \times 1$ in. and work off a separate 4.8v. 500 mAH power pack. All up airborne installation weight with three servos is approximately 19 oz. and the British price is £139. 10. 0d.





ORBIT QUADRUPLE PROPORTIONAL (U.S.A.) above: the Orbitrol system is an analog proportional control unit providing four independent proportional functions. The 10v. transmitter measures $8\frac{1}{4} \times 7 \times 2\frac{3}{4}$ in. and is available in two versions to provide single or dual control column coverage for the rudder, elevator and aileron commands with the throttle control on a separate lever. The single stick version is illustrated above. The receiver, size $2\frac{3}{4} \times 2\frac{1}{4} \times 1\frac{11}{15}$ in. weighs $7\frac{1}{2}$ oz. and employs twin deck circuit boards. Servo cables are led at off the receiver and connect to the feedback servos via four pin connectors. Each servo contains its own amplifier. Servo size is $1\frac{3}{8} \times 1\frac{1}{4} \times 1\frac{11}{16}$ in. and weight is 2 oz. Receiver and servos work off a common 1.25 AH. nickel cadmium battery pack, which brings the total airborne installation weight up to 27 oz. Price $595 in U.S.A.

CONTROLAIRE DIGITAL 5 (U.S.A.) right: a five function digital proportional control system. The transmitter is a twin control stick unit, measuring $7\frac{7}{8} \times 6\frac{3}{4} \times 2\frac{1}{2}$ in. and works off 12v. supply. The superhet receiver measures $2\frac{1}{2} \times 2\frac{1}{8} \times 1$ in. and works off a 7.2v. nickel cadmium power pack which also feeds the servos. The receiver is pre-wire to feed the servos via seven pin connectors. Each servo measures $2\frac{7}{8} \times 1\frac{7}{8} \times 1$, weighs $2\frac{3}{8}$ oz. and with linear output drive bears outward resemblance to the Annco multi servo. All-up airborne installation weight is 20 oz. Price $500 in U.S.A.



SURVEY OF R/C KITS

It is an interesting fact that as little as five years ago, the number of good kit models designed specifically for radio control could probably be counted on the fingers of two hands!

This survey covers most of today's radio control kits and the number and variety of kits detailed is a fair indication of how the radio control sport has blossomed in the past few years from a very minority interest practised by well versed experts into a hobby enjoyed by a large slice of the aeromodelling public.

Models have been tabulated according to engine capacity. It should however, be pointed out that these categories are not necessarily rigid and that a model placed in one category may also be suitable for another powerplant range.

For instance, the Top Flite Tauri is placed in the 2·5–5 c.c. class and is mentioned as a multi trainer for rudder, elevator and throttle controls, a purpose for which it was originally designed. This though, has not prevented some experienced modellers from installing 10 channel radio equipment and up to 8 c.c. powerplants.

This kind of "getting away with it" is of course a calculated move based on previous experience and admirably demonstrates that this survey should be followed as a general guide, followed according to the individual's personal experience.

0·15–0·3 c.c. (0·10–0·020 cu. in.)

Model	*Wing span (in.)*	*Length (in.)*	*Wing area (sq. in.)*	*Flying weight*	*No. of channels*	*Price*	*Other details*
Jetco Lightning-Bug (U.S.A.)	27	20	118	8 oz.	1	$3.50 (U.S.A.)	High wing; tailwheel U/C. Rudder control only
Top Flite Cessna (U.S.A.)	30			10 oz.	1	£2.9.11	Semi-scale outline; rudder and kick-up elevator controls
Top Flite Rascal	27			8 oz.	1	£1.16.6	High wing; rudder only control
Top Flite Roaring 20	21¼	19½	92	8 oz.	1	£1.16.6	Shoulder wing; rudder and kick-up elevator controls
Top Flite Schoolboy	27	23½	135	10 oz.	1	£2.5.0	High wing; rudder and kick-up elevator controls
Scientific Cessna 185 (U.S.A.)	30	21	140	8 oz.	1	$3.95 (U.S.A.)	High wing; semi-scale outline. Rudder control only
Scientific Miss World's Fair	30	22¾	143	8 oz.	1	$3.95 (U.S.A.)	High wing; rudder control only
Scientific Piper Cub	30	22½	130	8 oz.	1	$3.95 (U.S.A.)	High wing; semi-scale outline. Rudder only control
Veco Lil' Pinto (U.S.A.)	25		92	6½ oz.	1	$3.95 (U.S.A.)	Shoulder or low wing option. Rudder control only. Tricycle undercarriage

0·8–1·5 c.c. (0·49–0·099 cu. in.)

Model	*Wing span (in.)*	*Length (in.)*	*Wing area (sq. in.)*	*Flying weight*	*No. of channels*	*Price*	*Other details*
A-Amco S-Ray (U.S.A.)	50	38	425	2–2¾ lb.	1	£6.19.6	Shoulder wing; tricycle U/C. Rudder and throttle controls. 1 c.c. minimum power
de Bolt Ercoupe (U.S.A.)	36		230	18 oz.	1	$6.95 (U.S.A.)	Near scale appearance; rudder only controls. 0·8 c.c. only
de Bolt Kitten	34		220	18 oz.	1	$4.95 (U.S.A.)	High wing; rudder only. 0·8 c.c. power only
de Bolt Yankee	42		336	1¾–2¼ lb.	1	$7.95 (U.S.A.)	High wing; rudder only. 1 c.c. minimum power
Goldberg Jr. Falcon (U.S.A.)	37	28	250	16 oz.	1	£2.7.6	Shoulder wing. Tricycle U/C. 0·8 c.c. only
Goldberg Jr. Skylark	37	29	235	18 oz.	1	£2.19.6	Low wing; tricycle U/C. Twin 0·020 or single 0·049 power
Goldberg Skylane	42	35	244	22 oz.	1	£3.11.3	Near scale Cessna outline. Rudder only; 1 c.c. maximum power
Graupner Bolkow Jr. (Germany)	32½	25	200	36 oz.	1–2	£3.19.6	Scale; 1 c.c. maximum power. Rudder only
Graupner Consul	42	28¾	250	48 oz.	1–2	£5.17.6	High wing; tricycle undercarriage. Extensive use of expanded polystyrene in construction
Graupner Topsy	32¼	24	151	16 oz.	1–2	£1.19.6	High wing. 0·020 minimum, 0·049 maximum power
Midwest Bebe Jodel (U.S.A.)	46	30	396	48 oz.	1	$6.95 (U.S.A.)	Scale; low wing. Will require powerful 0·049. Rudder and throttle control
Midwest L-19 Bird Dog	46	30¼		30 oz.	1–4	$5.95 (U.S.A.)	Semi-scale. Will carry lightweight 4 channel equipment
Midwest Lil' Esquire	40	27½	320	24 oz.	1–2	$5.95 (U.S.A.)	High wing. Rudder and throttle controls
Midwest Lil' Tri-Squire	40		320	24 oz.	1–2	$5.95 (U.S.A.)	High wing, tricycle undercarriage. Rudder and throttle controls
Schuco-Hegi Frechdax (Germany)	43	28	210	20 oz.	1–2	£4.4.0	High wing; tricycle undercarriage. Rudder and throttle control
Schuco Hegi Starlet	39	31½	240	22 oz.	1–2	£7.6.0	Low wing; tricycle undercarriage. 1 c.c. maximum power
Scientific Miss America (U.S.A.)	42			30 oz.	1–2	$5.95 (U.S.A.)	High wing. Rudder only control. 1 c.c. maximum power
Sterling Minnie Mambo (U.S.A.)	36	25	210	18 oz.	1	$4.95 (U.S.A.)	High wing. Rudder only. 0·8 c.c. power maximum
Sterling Cosmic Wind	34	26	195	18 oz.	1	$7.95 (U.S.A.)	Semi-scale shoulder wing. Rudder only
Top Flite Schoolgirl (U.S.A.)	32	28	341	24 oz.	1	£3.15.0	Biplane. Rudder and throttle controls
Top Flite Schoolmaster	39	33	292	24 oz.	1	£3.12.6	High wing. Rudder, throttle and kick-up elevator controls

0·8–1·5 c.c. (0·49–0·099 cu. in.) (cont.)

Model	*Wing span (in.)*	*Length (in.)*	*Wing area (sq. in.)*	*Flying weight*	*No. of channels*	*Price*	*Other details*
Veco Pinto (U.S.A.)	38½		218	20 oz.	1	$6.95 (U.S.A.)	Shoulder or low wing. Rudder only. 1 c.c. maximum power
Veron Mini Robot (British)	36	28	205	18 oz.	1	£2.9.5	Shoulder wing; tricycle undercarriage. 0·8 c.c. only
Veron Tipsy Nipper	35	27	245	22 oz.	1–2	£3.11.6	Scale. Maximum power 1 c.c. Rudder control only

1·5–2·5 c.c. (0·099–0·15 cu in.)

Model	*Wing span (in.)*	*Length (in.)*	*Wing area (sq. in.)*	*Flying weight*	*No. of channels*	*Price*	*Other details*
A-Amco H-Ray (U.S.A.)	50	38	425	2¼–2¾ lb.	1–6	£7.19.6	High wing; tricycle undercarriage. Rudder and throttle control on single channel or up to 6 channels
Ambroid Charger (U.S.A.)	48	31	390	2–3 lb.	1–4	$14.95 (U.S.A.)	High wing; tricycle undercarriage. Will also operate with 3·5 c.c. motor
de Bolt Rebel (U.S.A.)	48		432	2½–3 lb.	1–4	$9.95 (U.S.A.)	High wing; rudder and throttle control
de Bolt Trainer	48		432	2–3 lb.	1–4	$9.95 (U.S.A.)	High wing; rudder and throttle control
Graupner Satelit (Germany)	48	33¼	430	2–3 lb.	1–4		High wing; rudder and throttle controls
Graupner Piper Tri-Pacer	43¾	31	340	3¼ lb.	1–4	£4.19.6	Scale; rudder and throttle controls
Graupner Piaggio 149 (Germany)	43¾	34½	305	4¼ lb.	1–4	£6.12.6	Scale; rudder and throttle controls. 2·5 c.c. only
Jetco Krackerjack (U.S.A.)	52½	34		2½–3 lb.	1–4	$14.95 (U.S.A.)	High wing; rudder and throttle controls 3·5 c.c. maximum power
Keil Kraft Mini Super (British)	48	35½	330	2–2½ lb.	1–4	£4.10.0	High wing; tricycle undercarriage. Rudder and throttle controls
Mercury Galahad (British)	54	38½	475	2–3 lb.	1–4	£1.17.1	Low wing. Rudder and throttle control
Mercury Matador	47	43	330	2–3 lb.		£1.6.5	High wing. Rudder and throttle controls
Midwest Esquire (U.S.A.)	50	34	500	2–4 lb.	1–4	$8.95 (U.S.A.)	High wing. 3·5 c.c. maximum power
Midwest Tri-Squire	51½	38	520	2–4 lb.	1–6	$11.95 (U.S.A.)	High wing; tricycle undercarriage. Up to 3·5 c.c. with 6 channels
Robbe Klemm 35 (Germany)	50	31	400	2–2¾ lb.	1–4	£4.9.0	Scale
Robbe Pan	51		470	3–3½ lb.	1–4	£4.5.6	High wing; tricycle U/C
Robbe Cessna 182	48		440	2¾–3¼ lb.	1–4	£5.4.6	Semi-scale
Sterling Cessna 180 (U.S.A.)	48	31¾	260	2–2½ lb.	1–4	$11.95 (U.S.A.)	Scale. Rudder and throttle controls
Sterling Fairchild P.T.19	45	36½	400	2–2½ lb.	1–4	$8.95 (U.S.A.)	Scale. Rudder and throttle controls

1·5–2·5 c.c. (0·099–0·15 cu. in.) (cont.)

Model	*Wing span (in.)*	*Length (in.)*	*Wing area (sq. in.)*	*Flying weight*	*No. of channels*	*Price*	*Other details*
Sterling Mambo	48	33	384	2–3 lb.	1–4	$7.95 (U.S.A.)	High wing. Rudder and throttle controls
Sterling Mambo Special	52	36½	435	2–3½ lb.	1–6	$11.95 (U.S.A.)	High wing; tricycle undercarriage. Rudder, elevator and throttle controls. Maximum power 3·5 c.c.
Sterling Piper Cub J.3	54	34½	405	2–3½ lb.	1–6	$9.95 (U.S.A.)	Scale. Rudder, elevator and throttle controls. Maximum power 3·5 c.c.
Veron Robot (British)	45	38	400	2–3½ lb.	1–6	£4.9.8	Shoulder wing. Rudder, elevator and throttle controls
Wik Cherie (Germany)	51	34½	500	2½–4 lb.	1–6		High wing; tricycle undercarriage

2·5–5 c.c. (0·15–0·29 cu. in.)

de Bolt Champion (U.S.A.)	56		600	3½–4½ lb.	1–6	$14.95 (U.S.A.)	High wing; rudder elevator and throttle controls
de Bolt Cosmic Wind	57		600	3½–5½ lb.	1–6	$14.95 (U.S.A.)	Semi-scale; rudder, elevator and throttle controls
de Bolt Super Cub	56		600	3½–4½ lb.	1–6	$14.95 (U.S.A.)	High wing; rudder, elevator and throttle controls
Enterprise Navigator (British)	54	40	540	3½–5 lb.	1–10	£7.10.0	Shoulder wing; tricycle U/C. Lightweight 10 channel equipment
Engel Akrobat (Germany)	53½			2½–4 lb.	1–4		Shoulder wing, tricycle undercarriage
Engel Iris	51	32¾		2–3 lb.	1–4		Shoulder wing
Engel Wotan	49	37¾	480	2–4 lb.	1–4		High wing
Frog Jackdaw (British)	60	41¼	550	3½–5 lb.	1–10	£4.19.6	High wing. Maximum power 6 c.c.
Goldberg Falcon U.S.A.)	56	43	558	2–4 lb.	1–6	£5.19.0	Shoulder wing; tricycle undercarriage. Rudder, elevator and engine controls
Goldberg Skylark	56	44	528	2½–4 lb.	1–6	£7.16.0	Low wing; tricycle U/C. Single or twin engine option
Graupner Floride (Germany)	55⅛			2½–4¼ lb.	2–10	£8.12.6	Shoulder wing; tricycle U/C. Weight factor critical with 10 channel equipment
Keil Kraft Super 60 (British)	63	47	618	4–6½ lb.	1–10	£5.9.11	High wing sports
Midwest Hustler (U.S.A.)	44½	31¾		3½–5½ lb.	4–10	$19.95 (U.S.A.)	Delta; tricycle U/C. Maximum power 6 c.c.
Robbe Dornier Do 27 (Germany)	54	41½	540	3–5 lb.	1–6	£8.12.6	Scale
Robbe Zeus	58	40		3–5½ lb.	4–10	£7.13.6	Shoulder wing
Schuco-Hegi Ranger (Germany)	58	38¾	510	4–6 lb.	4–6	£9.15.0	Shoulder wing; tricycle U/C. Multi sport model

2·5–5 c.c. (0·15–0·29 cu. in.) (cont.)

Model	*Wing span (in.)*	*Length (in.)*	*Wing area (sq. in.)*	*Flying weight*	*No. of channels*	*Price*	*Other details*
Sterling Rudder Bird (U.S.A.)	54	35	450	3½–5 lb.	1–6	$11.95 (U.S.A.)	Shoulder wing; tricycle U/ Rudder, elevator and thrott controls
Sterling Piper Tri-Pacer	58¾	39½	500	3½–5 lb.	1–6	$14.95 (U.S.A.)	Scale
Top Flite Tauri (U.S.A.)	57	38½	530	3½–5½ lb.	4–10	£10.19.6	Shoulder wing; tricycle U/ Multi trainer, for rudd elevator and throttle controls
Veco White Cloud (U.S.A.)	57	37½	577	3½–5 lb.	1–6	$10.95 (U.S.A.)	High wing; sports mode Rudder, elevator and thrott controls
V.K. Compact (U.S.A.)	62		650	4–6 lb.	1–10	$14.95 (U.S.A.)	Shoulder wing. Minimu power 3·5 c.c. Maximu power 6 c.c.
Veron Viscount (British)	48 or 54	38½	452 or 515	3½–4½ lb.	1–6	£6.8.1	Shoulder wing sports
Wik Diabolo (Germany)	55	39½		4–5½ lb.	1–6		Shoulder wing; tricycle U/ 6 c.c. maximum power, min mum 3·5 c.c.

6–10 c.c. (0·35–0·61 cu. in.)

Model	*Wing span (in.)*	*Length (in.)*	*Wing area (sq. in.)*	*Flying weight*	*No. of channels*	*Price*	*Other details*
Aviette President (British)	63	48	710	5–7 lb.	4–12	£7.19.6	Shoulder wing; tricycle U/ Multi trainer and aerobat model
de Bolt Sonic Cruiser (U.S.A.)	66		864	5–7 lb.	4–12	$19.95 (U.S.A.)	High wing; tricycle U/C. Mu trainer
de Bolt Jenny	57		620	4–6 lb.	4–12	$14.95	Shoulder wing, multi trainer
de Bolt Perigee	61		570	5–6 lb.	4–10		Low wing; tricycle U/ Aerobatic model
de Bolt Viscount	60		720	5–7 lb.	4–12	$26.95	Low wing; tricycle U/C, mu aerobatic type
Engel Feuervogel (Germany)	59			5–6 lb.	4–10		Maximum power 6 c.c. Lo wing; tricycle U/C. Aerobat type
Engel Jaguar	63	47	628	5–7½ lb.	4–10		Low wing; tricycle U/ Aerobatic type
Engel Mustfire	68		700	5–7½ lb.	4–12		Low wing, aerobatic type
Engel Me.109	67	53	870	6–8 lb.	4–12		Semi-scale. Aerobatic
Goldberg Sr Falcon (U.S.A.)	69	53	810	5–8 lb.	4–12	£11.18.0	Shoulder wing; tricycle U/ Multi trainer or aerobatic
Graupner Caravelle (Germany)	71	47¾	710	5–7½ lb.	2–12	£11.10.0	Shoulder wing; tricycle U/ Multi aerobatic model
Jetco Citation (U.S.A.)	62	50	740	5–7 lb.	4–12	$24.95 (U.S.A.)	Shoulder wing; tricycle U/ Multi aerobatic model
Robbe F.B.37 (Germany)	67½	51¾	1070	5–9 lb.	4–12	£12.11.0	Shoulder wing; tricycle U/ Multi aerobatic model

6–10 c.c. (0·35–0·61 cu. in.) (cont.)

Model	*Wing span (in.)*	*Length (in.)*	*Wing area (sq. in.)*	*Flying weight*	*No. of channels*	*Price*	*Other details*
obbe Thor	61	63¾	740	5–7 lb.	4–10	£9.1.6	Low wing; tricycle U/C. 8 c.c. maximum power
chuco Telstar Germany)	64	48½	630	5–7 lb.	4–12	£14.0.0	Shoulder wing; tricycle U/C.
terling ustang U.S.A.)	66	50	660	6–8 lb.	6–12	$27.50 (U.S.A.)	Near-scale. Aerobatic
terling iper Super Cub	72	47	715	5–8 lb.	1–12	$22.50 (U.S.A.)	Scale. Single channel or multi channel sports
terling P.63 ing Cobra	70	47	700	6–8½ lb.	6–12	$27.50 (U.S.A.)	Semi-scale. Aerobatic
terling ighty Mambo	68	45½	680	5½–7½ lb.	4–12	$19.95 (U.S.A.)	High wing; tricycle U/C. Multi trainer and sports
terling pitfire	64	54		6–8 lb.	6–12	$27.50 (U.S.A.)	Near-scale. Aerobatic
op Flite Taurus U.S.A.)	70	53	690	5½–7½ lb.	4–12	£16.10.0	Low wing; tricycle U/C. Aerobatic
eco eachcomber U.S.A.)	64½	47¾	760	5½–7½ lb.	4–12	$29.95	Low wing; tricycle U/C. Aerobatic
.K. Challenger U.S.A.)	60		665	5–7 lb.	4–12	$19.95 (U.S.A.)	High wing; tricycle U/C. Multi sports and aerobatics
eron Concord British)	66	52	780	5–7½ lb.	4–12	£11.15.0	Shoulder wing; tricycle U/C. Multi trainer and aerobatic
ik Picchio Germany)	67	47¼	800	6–8 lb.	6–12		Scale. Low wing; tricycle U/C. Aerobatic
ik Tiger	59	48¾	960	6–9 lb.	6–12		Biplane aerobatic

Gliders and Slope Soarers

viomodelli ellicano taly)	67½	42½	445	1–1¼ lb.	1–2		Power pod also supplied. Polyhedral wing. A/2 size
ngel Lo.100 Germany)	80	47¼	680	2½–3 lb.	1–4	£7.19.6	Vee dihedral wing. Near scale
ngel Mistral	106	54¼	815	3–4½ lb.	1–6		Near scale
ngel Stratos	81⅓	46½	687	2½–3 lb.	1–4		Vee dihedral wing
raupner Amigo Germany)	70	44½	520	1–1½ lb.	1–4	£3.17.6	Tip dihedral. A/2 size. Power pod for powered soaring
raupner Clou	75 or 95				1–6	£9.19.6	Long and short span for calm and windy conditions. Power pod also available
raupner Filou	50	33	290	¾–1 lb.	1–2	£2.17.6	Vee dihedral. All-up weight critical
raupner chleicher K10	79	41	525	2–3 lb.	1–6	£6.12.6	Scale
raupner eihe 50	72	33¾	370	2–2½ lb.	1–4	£4.9.6	Scale
obbe Baron Germany)	102¼	55	1070	4½–5½ lb.	1–10	£11.10.0	Semi-scale. Powered soarer. 3·5 c.c. motors

Gliders and Slope Soarers (cont.)

Model	*Wing span (in.)*	*Length (in.)*	*Wing area (sq. in.)*	*Flying weight*	*No. of channels*	*Price*	*Other details*
Robbe Donar	67½	45¾	525	2–3 lb.	1–4	£4.12.6	Vee dihedral. Tapered wing
Robbe Jugvogel	110	50¾	1010	4–5 lb.	2–10	£9.15.0	Near scale
Robbe Olympia	59	39½	520	2–3 lb.	1–2		Vee dihedral. May use 1 c. motor in power pod
Robbe Rhonadler KA. 7	73¼	44¾	520	2–2½ lb.	1–4	£5.6.0	Near scale. A/2 size
Schuco-Hegi Bergfalke (Germany)	90			3–4 lb.	1–8	£8.0.0	Near scale
Schuco-Hegi K8B	71			1–1½ lb.	1–4	£5.15.0	Semi-scale
Schuco-Hegi SB-7	90			2–3 lb.	1–6	£8.0.0	Semi-scale. High set tailplan
Schuco-Hegi Motorspatz	80	39		2–2½ lb.	1–4	£7.7.6	Semi-scale. Power assisted wit 0·8–1·5 c.c. motors
Wik Bjorn (Germany)	85	45	666	2–3 lb.	1–6		Semi-scale
Wik Standard (Austria)	87	45½	620	2–3 lb.	1–6		Scale. Butterfly tailplane

THE YEAR'S CONTESTS

AEROMODELLER TROPHY—R.A.F. Upwood—July 26th 1964

1	C. Olsen	C.M.	3310 points
2	S. Foster	Lincoln	3276 ,,
3	G. Franklin	Leicester	2740 ,,
4	J. Wingate	Chichester	2581 ,,
5	G. Ford	West Essex	2278 ,,
6	J. Bickerstaffe	Rugby	2224 ,,
7	M. Elmer	Lincoln	2032 ,,
8	R. Yates	North London	1998 ,,
9	R. Payne		1874 ,,

BRISTOL R/C RALLY—R.A.F. Hullavington—July 12th 1964

Multi

1	E. Johnson	Larkhill
2	S. Foster	Lincoln
3	G. Bradley	Lincoln

Pylon Race

1	C. Olsen	C.M.
2	J. Singleton	Larkhill

Scale

1	D. Thumpston	Sutton Coldfield	D.H.9
2	G. Franklin	Leicester	Spitfire IX
3	J. Morton	Bristol	Tiger Moth

BRITISH NATIONAL CHAMPIONSHIPS 1964—R.A.F. Barkstone Heath

Multi

1	F. Van den Bergh	Bromley	3604 points
2	G. Bradley	Lincoln	3398 ,,
3	C. Olsen	C.M.	3237 ,,
4	S. Foster	Lincoln	3136 ,,
5	P. Waters	South Wales	2951 ,,
6	G. Franklin	Leicester	2659 ,,
7	R. Brown	Lee Bees	2655 ,,
8	G. Pike	Nottingham	2558 ,,
9	D. Brogan	C.M.	2410 ,,
10	F/O Denney	R.A.F.M.A.A.	2365 ,,
11	E. Johnson	C.M.	2358 ,,
12	J. Morton	Winchester	2168 ,,
13	K. Jones	Sutton Coldfield	1995 ,,

14	R. Yates	North London M.S.	1970 ,,
15	G. Ford	West Essex	1875 ,,
16	J. Wingate	Chichester	1854 ,,
17	J. Bickerstaffe	Rugby	1847 ,,
18	D. Read	Rolls Royce	1726 ,,
19	R. Hargreaves	C.M.	1621 ,,
20	R. Fraser	Kirkaldy	1588 ,,
21	D. Allen	West Essex	1515 ,,
22	S. Sutherland	West Essex	1449 ,,
23	L. Blair	Larne N.I.	1267 ,,
24	K. Marsh	West Essex	1094 ,,
25	D. Neville	Reading	866 ,,

Scale

1	J. Morton	Winchester	D.H. Tiger Moth
2	D. Bryant	Bromley	Miles Sparrowhawk
3	D. Thumpston	Sutton Coldfield	Sopwith 1½ Strutter
4	J. Simmance	Wharfedale	Sopwith Swallow
5	D. Bateman	Luton	Bristol Scout Type D
6	B. Deniel	C.M.	D.H. 60 Moth
7	A. Devonshire	C.M.	D.H. 60 Moth

CLWYD SLOPE SOARING—July 12th 1964

Single

1	M. Fellows	Kidderminster	4: 1 error
2	L. Gwyn	LARCAS	5:15 ,,
3	J. Beer	Enfield	10:65 ,,

Multi

1	R. Donahue	LARCAS	84 points
2	J. Mountain	Kidderminster	45 ,,
3	M. Rainfoed	Liverpool	40 ,,

LINCOLN & WIGSLEY RALLY—Wigsley—July 9th 1964

Multi

1	S. Foster	Lincoln
2	M. Elmer	Lincoln
3	G. Franklin	Leicester

Scale

1	G. Franklin	Leicester
2	J. Archibald	
3	T. Devonshire	

Single

1 M. Ward
2 E. Scoles
3 A. Bird

NORTHERN GALA—R.A.F. Church Fenton—September 6th 1964

Multi

1	S. Foster	Lincoln	3870 points
2	J. Bickerstaffe	Rugby	3120 ,,
3	Stafford		2815 ,,

NORTHERN HEIGHTS GALA—R.A.F. Halton—September 6th 1964

R/C Spot landing

1	N. J. Butcher	Croydon	19.5 points
2	G. Shaw		21 ,,
3	B. Burt		32 ,,

NORTH WESTERN AREA EASTER MEETING 1964—R.A.F. Tern Hil

Multi

1	G. Bradley	Lincoln	6318 points
2	F. Knowles	Reigate	6288 ,,
3	S. Foster	Lincoln	6065 ,,

Scale

1	D. Thumpston	Sutton Coldfield	Sopwith 1½ Strutter

NORTH WESTERN AREA EASTER MEETING 1965—R.A.F. Tern Hill

Free Style

1	B. Denial	Doncaster	102 points
2	B. Purslow	LARCAS	92 ,,
3	A. Thomas	Sutton Coldfield	92 ,,

F.A.I. Multi

1	E. Johnson	Larkhill	1529.5 points
2	B. Purslow	LARCAS	1400 ,,

ROLLS ROYCE PYLON RACE—Derby—April 5th 1964

Single (4 minutes)

1	J. Lawton	Rolls Royce	3 laps
2	T. M. Black		2 ,,

Multi Pylon (6 laps)

1	C. Olsen	C.M.	1:24
2	P.T. Waters	South Wales	1:33

Multi Relay (10 laps)

1	Thomas/Sharpe	25½ laps
2	Pike/Purslow	25 ,,

SOUTH COAST RALLY 1964—Golden Cross

Multi

1	F. Knowles	Reigate
2	E. Johnson	Larkhill

Single (Spot landing)

1	R. Campbell	Wanstead

SOUTH MIDLAND AREA RALLY—Cranfield—September 27th 1964

Single

1	R. B. Tom	12.5 points
2	R. Redfern	74 ,,
3	S. R. Robinson	79 ,,
4	P. Thornton	87 ,,
5	G. Clover	107 ,,
6	B. Morley	107 ,,
7	J. Moore	103 ,,
8	D. Boddington	115 ,,
9	R. Campbell	118 ,,
10	A. Van Onselen	122 ,,

Multi Free Style Aerobatics

1	P. T. Waters	South Wales	466 points
2	G. D. Pike	Nottingham	417 ,,
3	F. Knowles	Reigate	386 ,,
4	S. L. Foster	Lincoln	365 ,,
5	D. J. Allen	West Essex	361 ,,
6	K. R. Jones	Sutton Coldfield	358 ,,
7	E. Johnson	Larkhill	337 ,,
8	B. Purslow	LARCAS	330 ,,
9	J. Morton	Winchester	312 ,,
10	D. Gale		304 ,,

FIRST TEAM TRIALS—R.A.F. Hemswell—September 20th 1964

1	P. Waters	South Wales	3381.0 points
2	S. Foster	Lincoln	3300.5 ,,
3	C. Olsen	C.M.	3104.5 ,,
4	F. Van den Bergh	Bromley	2941.5 ,,
5	G. Bradley	Lincoln	2858.5 ,,
6	F. Knowles	Reigate	2747 ,,
7	G. Pike	Nottingham	2743.5 ,,
8	D. Read		2662.5 ,,
9	G. Franklin	Leicester	2499.0 ,,
10	P. Rodgers	High Wycombe	2429.5 ,,

SECOND TEAM TRIALS

1	S. Foster	Lincoln	3498.5 points
2	C. Olsen	C.M.	3402.0 ,,
3	F. Van den Bergh	Bromley	3370.5 ,,
4	P. T. Waters	South Wales	3341.5 ,,
5	G. Pike	Nottingham	2959.5 ,,

Team selected for World R/C Championships, Sweden 1965:

S. Foster, C. Olsen, P. Waters. *Team Manager:* F. Van den Bergh.

WELSH RALLY—Swansea—May 31st 1964

Spot landing

1 P. Waters
2 R. Tom

WHAT DO THE TOP MODELLERS FLY?

British National

Name	Model	*Wing span (in.)*	*Wing area (sq. in.)*	*Wt. (lb.)*	*Wing section and thickness ratio*	*Engine*	*Prop. (in.)*
1. F. Van den Bergh	Skydancer Original Low wing	67	750	6¾	15% root to 20% tip Semi-symmetrical	Merco 49	11 × 6
2. G. Bradley	Scorpio Low wing Original	69	750	6¾	18% symmetrical	S/T 56	12 × 6
3. C. Olsen	Uplift Low wing Original	66	780	6	15% symmetrical	Merco 49	11 × 6
4. S. Foster	Nimbus II Low wing	64	740	6½	15% semi-symmetrical	S/T 56	12 × 6
5. P. Waters	Altair Low wing	73	740	6¾	22% semi-symmetrical	Merco 49	12 × 6
6. G. Franklin	Allegro Low wing	74	710	8	18% semi-symmetrical	Merco 61	12 × 6
7. R. Brown	Encore III Low wing Original	68	800	6¾	14% symmetrical	Merco 49	11 × 6
8. G. Pike	Orion Low wing	68	690	6¾	NACA 2415 15%	Merco 49	11 × 6
9. D. Brogan	Taurus Low wing	69	720	6¼	NACA 2419 19%	Veco 49	11 × 6
10. F/O G. Denny	Big King Rastus Low wing	70	850	9	19%	McCoy 60	12 × 6

World Radio Control

Name	Model	*Wing span (in.)*	*Wing area (sq. in.)*	*Wt. (lb.)*	*Wing section and thickness ratio*	*Engine*	*Prop. (in.)*
1. R. Brooke (U.S.A.)	Amanusa Low wing	72	720	6½	NACA 0018 18% symmetrical	Veco 45	11 × 6
F. Bosch (Germany) (Equal 1st place)	FB-37 Shoulder wing	67½	1070	9	Symmetrical 20%	S/T 56	12 × 6

VITAL STATISTICS OF NATIONAL AND INTERNATIONAL CONTEST WINNING DESIGNS

Championships 1964

Transmitter	*Receiver*	*Servos*	*Control system*	*Remarks*
Orbit 10 Transistor	Orbit 10 Superhet (Reed)	Bonner Transmite	REMAT Reeds	Tricycle U/C; steerable. ¾ span ailerons. Mechanical kick-up elevator for spin. Tapered wing
F. & M. Matador	F. & M. Midas (Reed)	Bonner Duramites. Brooks amplifiers	REMAT Reeds	Tricycle U/C; steerable. Tapered wing, strip ailerons
R.C.S. 10	R.C.S. 10 Superhet (Reed)	Bonner Duramites. Brooks amplifiers	REMAT Reeds	Tricycle U/C; constant chord wing. Tip type inset ailerons
F. & M. Matador	F. & M. Midas (Reed)	Bonner Duramites. Brooks amplifiers	REMAT Reeds	Tricycle U/C; steerable. Tapered wing. Strip ailerons
Min-X 10 Powermite	Min-X 10 Superhet (Reed)	Bonner Duramites. Brooks amplifiers	REMAT Reeds	Tricycle U/C; steerable. Taper wing. Strip ailerons
Franklin 12	Franklin 12 Superhet (Reed)	Bonner Duramites. Franklin amplifiers	REMAT Reeds	Tricycle U/C; retractable; steerable. Tapered wing. Strip ailerons
Orbit 10 Transistorised	Orbit 10 Superhet (Reeds)	Bonner Transmites	REMAT Reeds	Tricycle U/C. Constant chord wing
Space Control	Space Control	Space Control	REMA Proportional	Tailwheel U/C. Tapered wing. Inset tip type ailerons
Orbit 10 Transistor	Orbit 10 Superhet (Reed)	Bonner Transmites	REMAT Reeds	Tricycle U/C; steerable. Tapered wing. Strip ailerons
Johnson 10	Johnson 10 (Reed)	Bonner Duramites. Johnson amplifiers	REMAT Reeds	Tricycle U/C. Constant chord wing

Championships 1963

Orbit Proportional	Orbit Proportional	Orbit PS-1	REMA Proportional	Tricycle U/C; steerable. Taper wing. Strip ailerons
Telecont 9	Telecont 9 (Filter)	Bonner Duramites	REMAT (Filters)	Tricycle U/C. Taper wing. Strip ailerons

World Radio Control

Name	*Model*	*Wing span (in.)*	*Wing area (sq. in.)*	*Wt. (lb.)*	*Wing section and thickness ratio*	*Engine*	*Prop. (in.)*
3. E. Kazmirski (U.S.A.)	Taurus Low wing	69	690	5¾	NACA 2419 19%	Veco 45	11 × 6
4. P. Louis (Belgium)	Taurus Low wing	69	690	6½	NACA 2419 19%	Veco 45	11 × 6
5. G. Nelson (U.S.A.)	Cumulus Low wing	70	865	6¼	Symmetrical 17%	Veco 45	11 × 6
6. C. Culverwell (South Africa)	Taurus Low wing	69	690	5¾	NACA 2419 19%	Veco 45	11 × 6
7. F. Van den Bergh (Great Britain)	Skydancer Low wing	67	750	6¾	Symmetrical 15–20%	Merco 49	11 × 6
8. C. Teuwen (Belgium)	Taurus Low wing	69	690	6¼	NACA 2419 19%	Veco 45	12 × 6
9. P. Marot (France)	Taurus Low wing	69	690	6½	NACA 2419 19%	Veco 45	11 × 6
10. H. Tom (Canada)	Taurus Low wing	69	690	6¼	NACA 2419 19%	Veco 45	11 × 6

United States

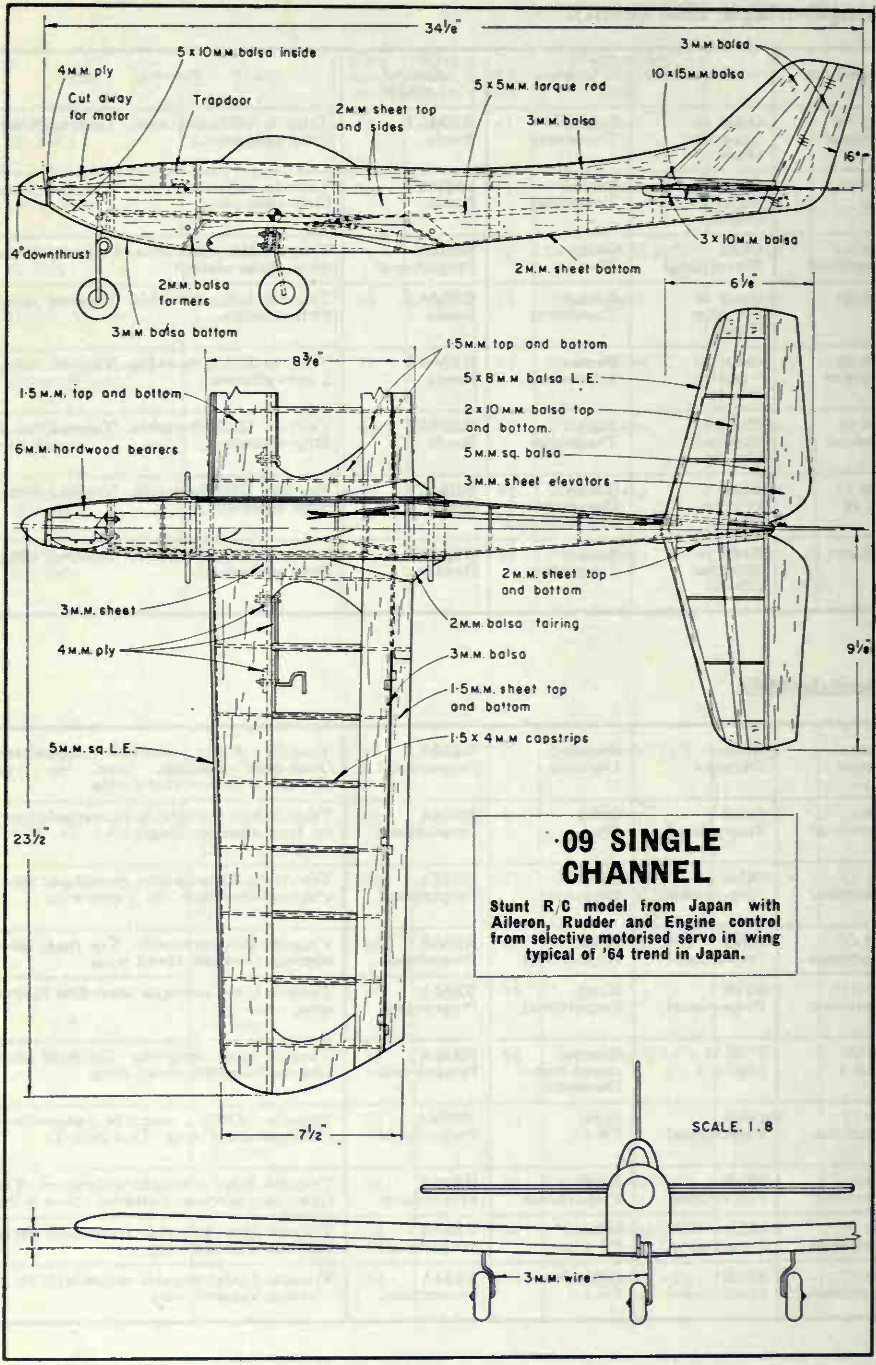
1. C. Weirick	Candy Low wing	70	840	8	Symmetrical 15%	S/T 60	11 × 8
2. Z. Ritchie	Original Phantom Low wing	66	800	8		Fox 59	12 × 6
3. R. Brooke	Original Crusader Low wing	69	700	7¼	NACA 0018 symmetrical 18%	S/T 60	11 × 7
4. P. Kraft	Kwick-Fli Low wing	66	800	6¾	Symmetrical 18%	S/T 60	12 × 6
5. D. Usher	F-10 Low wing Original	66	670	7¼		S/T 56	12 × 6
6. E. White	Candy Low wing	68	748	7½	Symmetrical 15%	S/T 60	11 × 7
7. G. Nelson	Patriot Low wing Original	66	720	6¼		S/T 56	12 × 6
8. D. Spreng	Kwick-Fli Low wing	66	792	7	Symmetrical 15%	S/T 56	12 × 6
9. L. Fruh	Taurus II Low wing	68	680	6¼	NACA 2422 (Mod.) 22%	S/T 56	11 × 8
10. J. Kirkland	Beachcomber Low wing	66	792	6¼	Symmetrical 14%	Veco 45	11 × 6

Championships 1963 (cont).

Transmitter	*Receiver*	*Servos*	*Control system*	*Remarks*
Orbit 10 Transistor	Orbit 10 Superhet (Reed)	Bonner Transmites	REMAT Reeds	Tricycle U/C; steerable. Tapered wing. Strip ailerons
Orbit 10 Valve	Orbit Superhet (Reed)	Bonner Transmites	REMAT Reeds	Tricycle U/C; steerable. Tapered wing. Strip ailerons
Orbit Proportional	Orbit Proportional	Orbit PS-1	REMA Proportional	Tricycle U/C; steerable. Constant chord wing. Strip ailerons
Kraft 10	Kraft 10 Superhet (Reed)	Bonner Transmites	REMAT Reeds	Tricycle U/C; steerable. Tapered wing. Strip ailerons
Orbit 10 Transistor	Orbit 10 Superhet (Reeds)	Bonner Transmites	REMAT Reeds	Tricycle U/C; steerable. Tapered wing. ¾ span ailerons
Orbit 12 Transistor	Orbit 12 Superhet (Reeds)	Bonner Transmites	REMAT Reeds	Tricycle U/C; steerable. Tapered wing. Strip ailerons
Radio Pilot 10	Radio Pilot 10 (Reed)	Bonner Duramites—own amplifiers	REMAT Reeds	Tricycle U/C; steerable. Tapered wing. Strip ailerons
Ace/Kraft 10	Kraft 10 Superhet (Reeds)	Bonner Transmites	REMAT Reeds	Tricycle U/C; steerable. Tapered wing. Strip ailerons

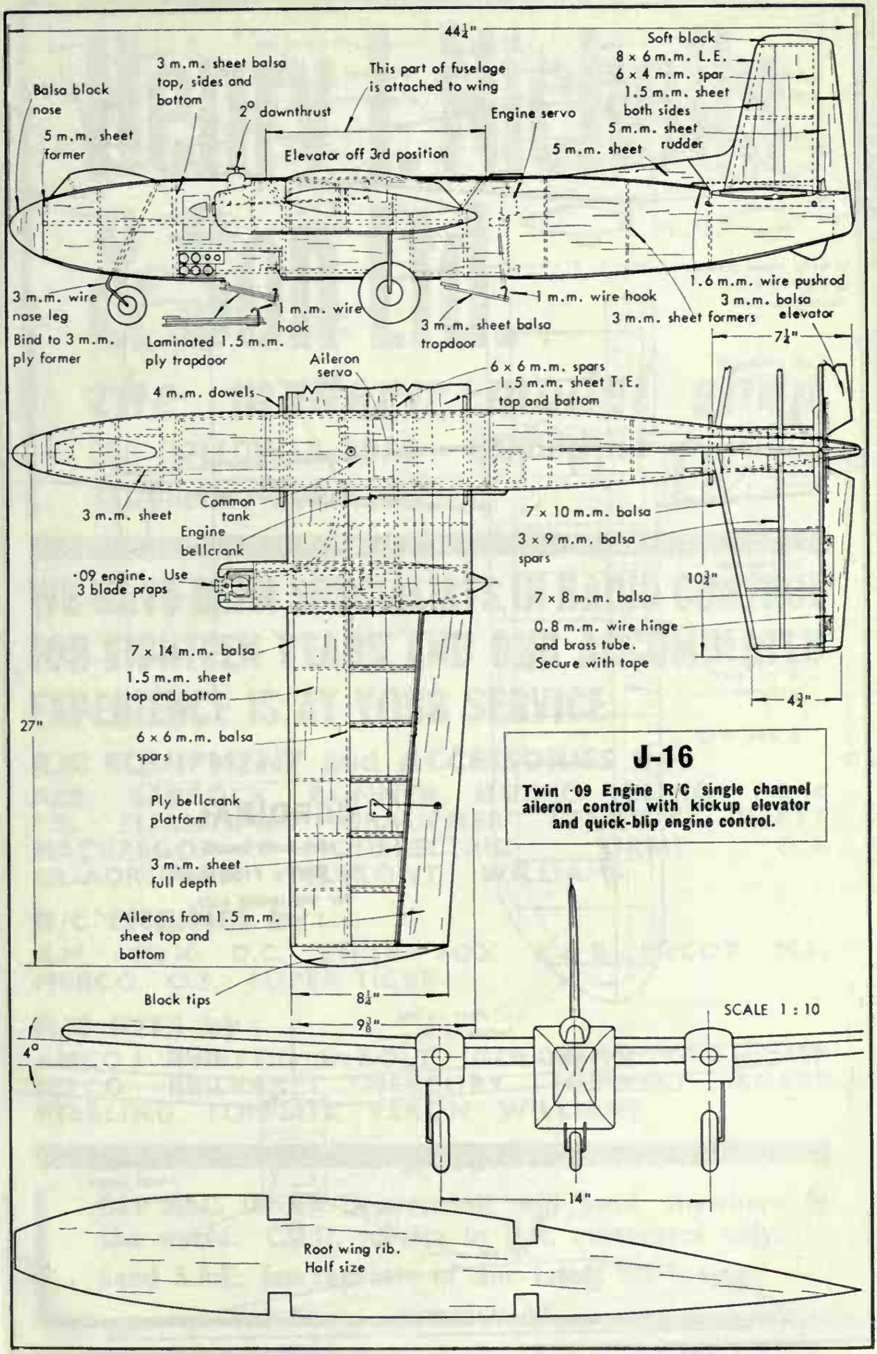
Nationals 1964

Bonner Digimite	Bonner Digimite	Bonner Digimite	REMA Proportional	Tricycle U/C; steerable nosewheel. Glass-fibre fuselage. Inset tip type ailerons. Constant chord wing
Orbit Proportional	Orbit Proportional	Orbit PS-1	REMA Proportional	Tricycle U/C; steerable nosewheel. Inset tip type ailerons. Single stick Tx. Taper wing
Orbit Proportional	Orbit Proportional	Orbit PS-1	REMA Proportional	Tricycle U/C; steerable nosewheel. Strip ailerons. Two stick Tx. Taper wing
Kraft Proportional	Kraft Proportional	Kraft Proportional	REMA Proportional	Tricycle U/C; steerable. Tip type, inset ailerons. Constant chord wing
Kraft Proportional	Kraft Proportional	Kraft Proportional	REMA Proportional	Tricycle U/C; steerable nosewheel. Taper wing
F. & M. Digital 5	F. & M. Digital 5	Bonner closed loop Duramite	REMA Proportional	Tricycle U/C; steerable. Tip type inset ailerons. Constant chord wing
Orbit Proportional	Orbit Proportional	Orbit PS-1	REMA Proportional	Tricycle U/C; steerable nosewheel. Constant chord wing. Two stick Tx
Kraft Proportional	Kraft Proportional	Kraft Proportional	REMA Proportional	Tricycle U/C; steerable nosewheel. Tip type inset ailerons. Constant chord wing
Orbit Proportional	Orbit Proportional	Orbit PS-1	REMA Proportional	Tricycle U/C; steerable nosewheel. Strip ailerons. Tapered wing
Orbit Proportional	Orbit Proportional	Orbit PS-1	REMA Proportional	Tricycle U/C; steerable nosewheel. Strip ailerons. Tapered wing


34⅛"
5 x 10 M.M. balsa inside
4 M.M. ply
Cut away for motor
Trapdoor
2 M.M. sheet top and sides
5 x 5 M.M. torque rod
3 M.M. balsa
3 M.M. balsa
10 x 15 M.M. balsa
16"
3 x 10 M.M. balsa
4° downthrust
2 M.M. balsa formers
3 M.M. balsa bottom
2 M.M. sheet bottom
6⅛"
8⅜"
1·5 M.M. top and bottom
1·5 M.M. top and bottom
5 x 8 M.M. balsa L.E.
2 x 10 M.M. balsa top and bottom.
6 M.M. hardwood bearers
5 M.M. sq. balsa
3 M.M. sheet elevators
2 M.M. sheet top and bottom
3 M.M. sheet
2 M.M. balsa fairing
4 M.M. ply
3 M.M. balsa
1·5 M.M. sheet top and bottom
9⅛"
5 M.M. sq. L.E.
1·5 x 4 M.M. capstrips
23½"
7½"
SCALE. 1:8
1"
3 M.M. wire

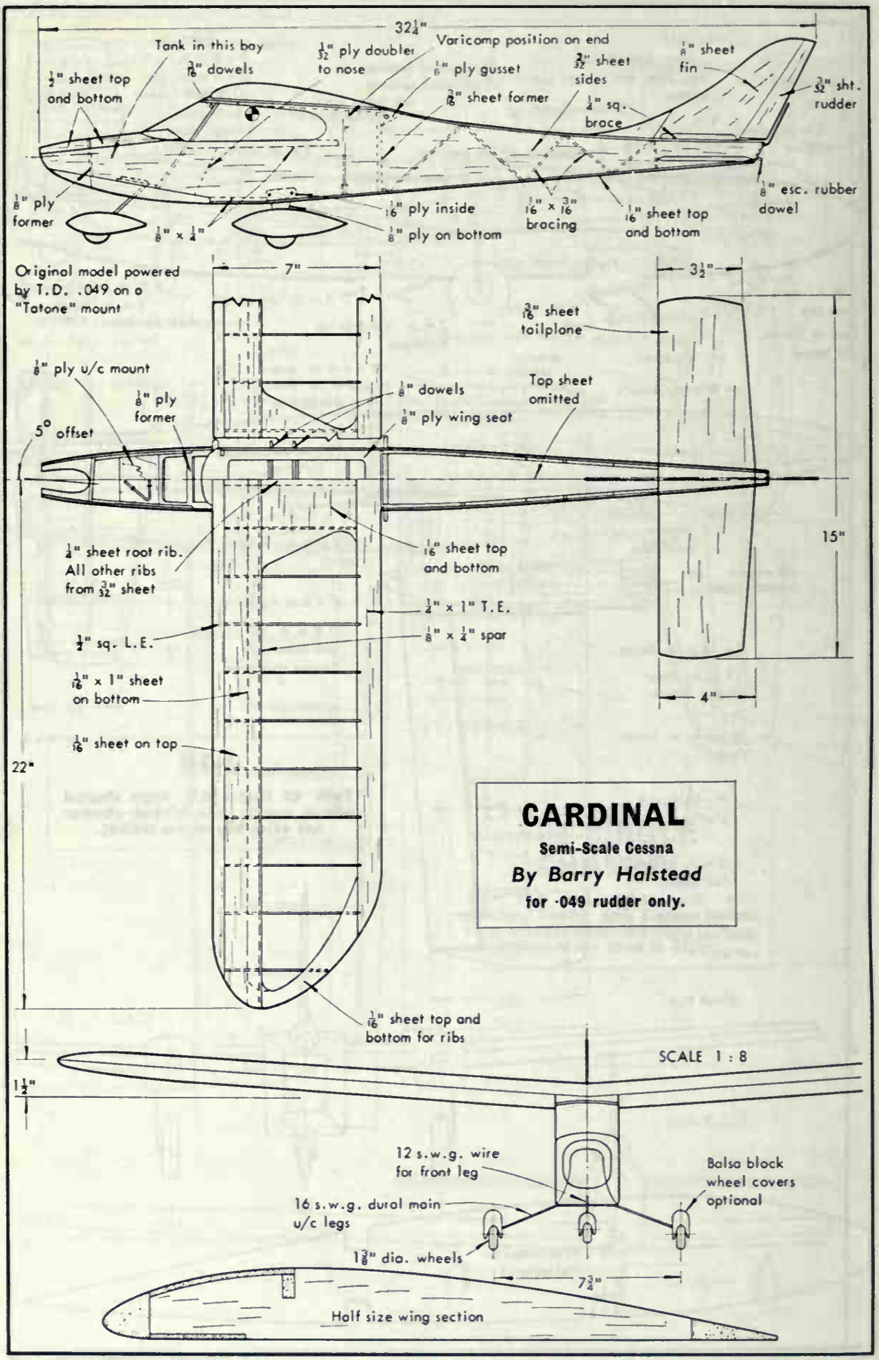
·09 SINGLE CHANNEL

Stunt R/C model from Japan with Aileron, Rudder and Engine control from selective motorised servo in wing typical of '64 trend in Japan.


44¼"
Balsa block nose
3 m.m. sheet balsa top, sides and bottom
This part of fuselage is attached to wing
Soft block
8 x 6 m.m. L.E.
6 x 4 m.m. spar
1.5 m.m. sheet both sides
5 m.m. sheet rudder
5 m.m. sheet former
2° downthrust
Engine servo
5 m.m. sheet
Elevator off 3rd position
3 m.m. wire nose leg
Bind to 3 m.m. ply former
Laminated 1.5 m.m. ply trapdoor
1 m.m. wire hook
3 m.m. sheet balsa trapdoor
1 m.m. wire hook
1.6 m.m. wire pushrod
3 m.m. balsa elevator
3 m.m. sheet formers
7¼"
Aileron servo
6 x 6 m.m. spars
1.5 m.m. sheet T.E. top and bottom
4 m.m. dowels
3 m.m. sheet
Common tank
Engine bellcrank
·09 engine. Use 3 blade props
7 x 10 m.m. balsa
3 x 9 m.m. balsa spars
10¾"
7 x 8 m.m. balsa
0.8 m.m. wire hinge and brass tube. Secure with tape
4¾"
7 x 14 m.m. balsa
1.5 m.m. sheet top and bottom
27"
6 x 6 m.m. balsa spars
Ply bellcrank platform
3 m.m. sheet full depth
Ailerons from 1.5 m.m. sheet top and bottom
Block tips
8¼"
9⅜"
SCALE 1 : 10
4°
14"
Root wing rib. Half size

J-16

Twin ·09 Engine R/C single channel aileron control with kickup elevator and quick-blip engine control.


32¼"
Tank in this bay
1/32" ply doubler to nose
Varicomp position on end
1/8" sheet fin
1/2" sheet top and bottom
3/16" dowels
1/16" ply gusset
3/32" sheet sides
3/32" sht. rudder
3/16" sheet former
1/4" sq. brace
1/8" ply former
1/8" × 1/4"
1/16" ply inside
1/8" ply on bottom
1/16" × 3/16" bracing
1/16" sheet top and bottom
1/8" esc. rubber dowel
7"
3½"
Original model powered by T.D. .049 on a "Totone" mount
3/16" sheet tailplane
Top sheet omitted
1/8" ply u/c mount
1/8" ply former
1/8" dowels
1/8" ply wing seat
5° offset
15"
1/4" sheet root rib. All other ribs from 3/32" sheet
1/16" sheet top and bottom
1/4" × 1" T.E.
1/2" sq. L.E.
1/8" × 1/4" spar
1/16" × 1" sheet on bottom
4"
1/16" sheet on top
22"
1/16" sheet top and bottom for ribs
SCALE 1 : 8
1½"
12 s.w.g. wire for front leg
Balsa block wheel covers optional
16 s.w.g. dural main u/c legs
1⅜" dia. wheels
7¾"
Half size wing section

CARDINAL

Semi-Scale Cessna

By Barry Halstead

for ·049 rudder only.

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F.R. FLIGHTLINK GRAUPNER GRUNDIG KRAFT
MACGREGOR MODELECTRIC ORBIT O.S.
QUADRUPLEX TELECONT WILLIAMS

R/C ENGINES by:
A.M. COX D.C. ENYA FOX K & B McCOY M.E.
MERCO O.S. SUPER TIGRE

R/C KITS by:
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JETCO KEILKRAFT MERCURY MIDWEST ROBBE
STERLING TOPFLITE VERON WILLIAMS

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- New Compact Designs. Tx-12s is only 7" × 5½" × 2¾"!
- All 12 Volt operation, with built-in Charging Jack for DEACs or NICADs.
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- Perfect Tone Stability and Power Output from 0 to 140 degrees, even with 30 per cent Battery Voltage Drop.
- Crystal Controlled on Bands 1-2-3-4-5, all of which may be flown together.
- Highest Quality Silicone Transistors and Tone Torrids.
- Centre Loaded Aerial and Low 65 mA Battery Drain on Signal.
- Many other O.S. Custom Built exclusive features.

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- Compact 6 Volt Designs, in Unbreakable Anodised Hardened Dural Case.
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TRANSMITTER

6 CHANNEL
Transmitter and Receiver
Superhet simultaneous
Price to be announced

10 CHANNEL SUPERHET
Transmitter and Receiver
Superhet simultaneous **£95.10.0**

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Transmitter and Receiver
Superhet simultaneous **£97.11.9**

REMEMBER—WITH O.S. SUPERHET YOU CAN FLY FIVE PLANES AT ONCE—NO MORE WAITING IN THE QUEUE!

O.S. PIXIE

Single Channel Transmitter and Relay Receiver

£16.15.0

O.S. ESCAPEMENTS

S.2 (2 Claw)	...	£2 7 4
S.4 (4 Claw)	...	£2 0 11
K.1 Compound	...	£2 16 3
K.2 ...	... ...	£2 9 1

O.S. SERVOS (Single Channel)

S-101 Rudder Servo	£5 2 4
S-101M Motor Servo	£4 10 6

FEATURING

- Guaranteed out-of-sight range.
- Guaranteed Temperature Stability.
- Transmitter & Receiver both operate off 9 volts.
- Transmitter has centre loaded aerial and is crystal controlled.
- Receiver has nylon case, weighs 1¼ oz. and includes a relay.
- Receiver is suppressed for electric Servo use.

OUTSTANDING ALL TRANSISTOR DESIGN WITH A MIGHTY PERFORMANCE!

OBTAINABLE AT ALL KEILKRAFT AGENTS

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'CUSTOM SPECIAL' R/C Engines

A completely new range of super engines designed for—

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- **FAULTLESS IDLING**
- **COMPLETE FLEXIBILITY**
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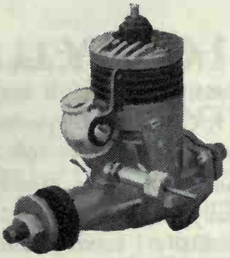
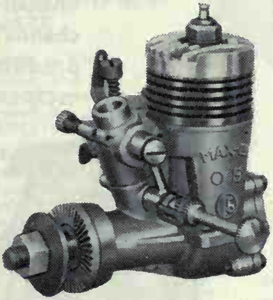
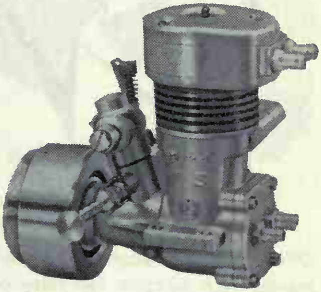


PET 09 R/C ...	63s. 9d.
PET 09 Standard	53s. 2d.



MAX 15 R/C ...	151s. 2d.
MAX 19 R/C ...	169s. 5d.



MAX 19 R/C MARINE ...	222s. 6d.
MAX 19 MARINE Standard ...	189s. 0d.

MAX 29 R/C ...	160s. 7d.
MAX 30 R/C ...	176s. 3d.

O.S. "JETSTREAM" SILENCERS

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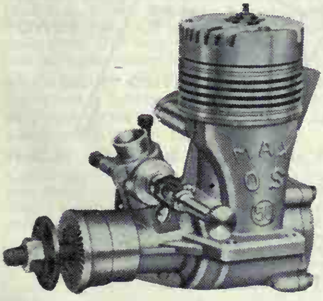

MAX 35 R/C ...	162s. 11d.
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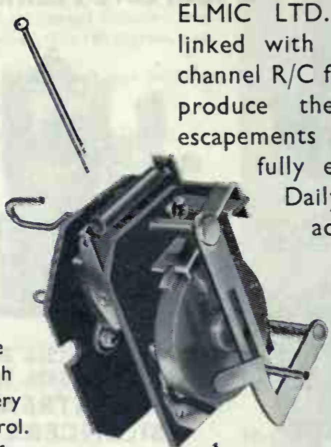
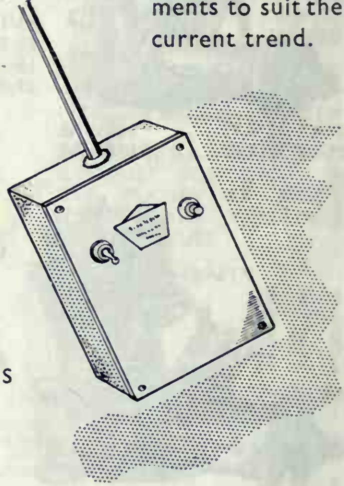
ELMIC LTD., the Company linked with successful single channel R/C flying everywhere, produce the finest of all escapements in their modern, fully equipped factory. Daily contact with active modellers enables the designers to embody all the features desired and Elmic tailor their escapements to suit the current trend.





Offering a full range of escapements, each suitable for relay or relayless receivers, ELMIC provide a selection of actuators from which to choose the perfect unit in every class of single channel Radio Control. Backed by a speedy and efficient "after-sales" service, ELMIC products pave the way to success for novice and expert alike.

Commander	Rudder and Motor Control. Quick Blip switch. S/N.
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Corporal	Motor Control unit for Compact or Commander.
Compact	Miniature. Rudder, Elevator K/U and Q.B. Motor Control.

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POWER
GUIDANCE SYSTEM

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FROM BRITAIN'S LARGEST AND BEST MANUFACTURER

R.C.S. Competition 10 (Mk. II TX)
Slimline Superhet Rx. 7.2 volt operation. Size only 3" × 1⅞" × 1". Weight 3 oz. Transmitter all transistor. 12v. DEAC. Twin modulators. Xtal controlled. R.F. meter. Half watt output. Tx. £39. Rx. £24. COMPLETE OUTFIT £62.

R.C.S. Sports 10 Outfit (SUPER POWER TX)
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Slimline Super-regen Rx. as above but with 6 Ch. Reed Bank. New design Tx. ½ watt output. £34.

R.C.S. Marine 6 Outfit (SUPER POWER)
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R.C.S. Inter 6 Outfit
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SUPERHET VERSION £69.10.0.

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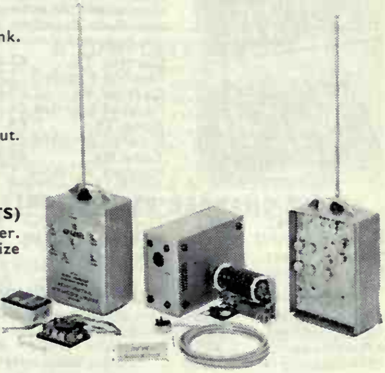

R.C.S. Tasamite Amplifier
(For Bonner Servos) £3.8.0.

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(The Best Outfit Available Anywhere.) **WITH SUPER POWER TX.** All transistorised. Single channel. Xtal controlled. Half watt output Tx. 12 volt operation. New design Rx. with quick blip facility for motor control. Rx. £6.10.0. Tx. only £7.10.0. Complete £13.13.0.

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Case: Moulded nylon with brass screw inserts. Iron Circuit: Cadium plated soft iron. Reed Comb: Hard gold plated Swedish spring steel. Contact Board: Gold plated printed circuit. Sensitivity: Min. drive for reliable operation 2v. R.M.S. recommended 3-4 volts. Ex-stock £6.10.0.

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TODAY'S BEST BUY!

The MacGregor range offers you QUALITY PLUS—every item fully guaranteed and designed for 100% reliability.

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The fabulous all-transistor relayless tone receiver that you can truly 'fit and forget' for completely reliable operation under all conditions. Size: 2″ × 1⅝″ × ⅝″. Wt. ¾ oz. Takes 3 to 4.5 volt battery. **Price only £8.19.6.**

TONE Tx. **£10.19.6**
Super-power Xtal controlled. Works on 18 volt battery.

C/MOD Tx. **£8.19.6**
High-power 'economy' transmitter for CARRIER or TONE.

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Just assemble following simple step-by-step instructions. Anyone can put them together and get complete success!

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Citizenship PSN2	59/6
Elmic Conquest	35/-
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Elmic Commander	52/3
Commander cmpd.	59/2
Elmic Compact	67/4

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RMK Dynamo	83/6
RMA Miniservo	65/-
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Graupner Unimatic	79/6
Switch and Link *	15/-
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* for boats only

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27″ Rascal	£1.16.6
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32″ Schoolgirl	£3.15.0
30″ Cessna	£2.9.11
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All these models specially designed for single-channel radio control.

32″ Topsy	£1.19.6
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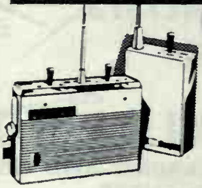
GRUNDIG

GRUNDIG RADIO CONTROLS REPRESENT THE ULTIMATE IN RELIABILITY AND SIMPLICITY OF INSTALLATION & OPERATION NO TUNING OR ADJUSTMENT REQUIRED — ALL UNITS PLUG TOGETHER POSITIVELY WITHOUT WIRING UP OR SOLDERING.



- ★ Ultra-modern all-transistor tone filter circuits
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10-channel	£54.10.0
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Super-regen Rx.	£10.19.6
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Filters	£10.19.6

(2 channels each, plug on to basic receiver)

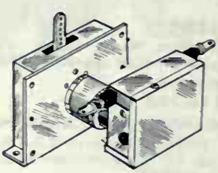
Matching Crystals (superhet combo) 50/- each

Wiring harness	35/-
Plain harness	12/6

Graupner

MULTI-CHANNEL SERVOS

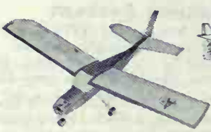
Bellamatic II	£6.15.0
(2 position, neutralising)	
Speed Regulator	£1.15.0
Servoautomatic	£3.19.6
Servoautomatic II	£5.19.6
Trimomatic	£5.17.6



'RMA' SERVOS

Selectagear	£3. 5.0
Permagear	£4. 2.6
Maxamite	£4. 5.0
Maxamite T *	£9.19.6
Maxamite G **	£4.19.6

* with amplifier
** with 8-pin miniplug



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Shoulder wing model

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The ideal 'multi' trainer for 2- to 8-channel. Now with strip ailerons.

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SEE THEM ALL AT

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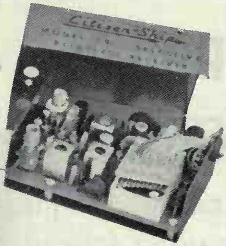
RIPMAX are SPECIALIST Radio Control suppliers, handling only the WORLD'S BEST in R/C equipment

MULTI-CHANNEL (REED)

CITIZEN SHIP RADIO



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10-ch Superhet. Tx and Rx combo	£89.10.0
6-ch Superhet. Tx and Rx combo	£54.16.0

Multidyne £4.19.6
Self-neutralising or progressive (trim) for relay receivers.

Amplidyne Trim £8.9.6
Trim servo with amplifier for relayless receivers.

RMK DYNAMIK SERVOS

The very latest in miniature precision 'multi' servos, manufactured to the highest possible standards. Suit all 'multi' receivers.

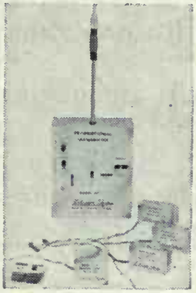
Amplidyne-SN £8.19.6
Self-neutralising, relay-less.

Mounting board	£1.12.6
Mounting frame (4 up)	19/6
Mounting frame (3 up)	15/-

CITIZEN SHIP RADIO

PROPORTIONAL

ANALOG SYSTEM



A new LOW COST system which gives DUAL SIMULTANEOUS FULLY PROPORTIONAL controls WITH TRIM, plus MOTOR SPEED. Superhet Rx for immunity from interference and FULLY STABILISED CIRCUITRY. Extra servo may be added for coupled AILERONS & RUDDER. Price **£125.0.0** complete Additional servo **£17.10.0** Tx only **£52.10.0.** Rx only **£42.10.0.**

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33" Bolkow	£5.17.6
55" Floride *	£8.12.6
79" K-10 *	£6.12.6
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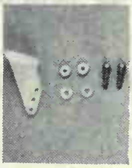
71" Caravelle *	£11.10.0

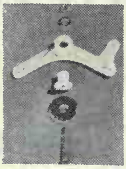
* also for proportional

TOP FLITE **R/C MODEL ACCESSORIES**



Nylon control horn assembly 3/-
½A bellcrank and horn 3/-

Nylon aileron bellcrank assy. 9/6
Metal aileron horn, etc. 7/6



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Nylon bell-cranks 2" 3/- 3" 3/9

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TOP FLITE In precision-moulded nylon or wood.
PROPELLERS Sizes from 5½" × 3" to 12" × 6"

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SEMO PROPS Full range in nylon

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R/C FOR BOATS!

The KINEMATIC servo (82/6) gives rudder PLUS motor switching off standard single channel for MINIMUM COST COMPLETE CONTROL.

RECOMMENDED for use with MINIMAC Rx and MacGREGOR Tx (or MacGregor KIT units).

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Positively the finest and most complete kits of their type to be found any where. AMAZING VALUE FOR MONEY!

39" Theodor Heuss	£7.19.6
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ECHO Transmitter—6v., all transistor
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SATURN—3v. super-regen, relay
VANGUARD—3v. superhet, relay

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The Finest Multi Available Today
10 Channel Reed Equipment
MATADOR—6v. transistor transmitter
Ground range over 1 mile
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Proportional

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System includes:
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  Digital superhet receiver with power pack
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ASTRAL Tx: High quality single channel transmitter incorporating a silicon output device rated at 2 watts.

Minimum guaranteed ground range of 800 yards using Modelectric Rx.

Highly efficient aerial and circuitry for high R.F. output combined with long battery life.

Beautifully balanced in handsome case specially designed for perfect hand grip.

Price £11 . 9 . 9

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TRANSISTORISED TRANSMITTER
MODELECTRIC Ltd.
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MINIMOD Rx: The neatest of little relayless super-regen receivers.

Only ½ oz. weight. Only 1¾ × 1⅛ × ½ in. High output (500 mA). Unaffected by motor interference. Uses 3-4.5 volts. Prang resistant.

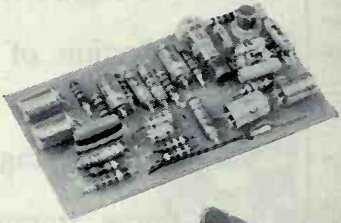
Price £8 . 17 . 6

MINIMOD
27 Mc.
MODEL-CONTROL
TELESWITCH

OR A RELIABLE RX. KIT.

KIT VERSION: The same circuit but on an enlarged p.c. board for ease of assembly . . .

Only £5 . 9 . 6



HAVE A RELIABLE ACTUATOR.

SLIM JIM (relayless): This servo incorporates a transistorised circuit which enables it to operate from relayless receiver. Only a single battery is required to operate both servo, and the secondary unit, which may be rubber driven or motorised. Completely enclosed contact surfaces.

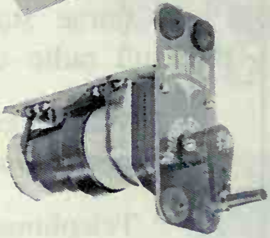
Operates from 4.5 volts. Weight 1½ oz.

Price £4 . 15 . 0

Also single channel actuator; which will replace most rubber or clockwork actuators, giving 2 or 4 positions as required, can be used with relay or relayless receivers, also for use as secondary actuator.

Price £3 . 8 . 0

All Slim-Jim servos use first quality switching plates flush-bonded and rhodium plated, with silver wire contacts completely enclosed for protection from oil and dirt. Front plate measurements: 2⅞ × ⅞ in.



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*** Ideal for boats too**

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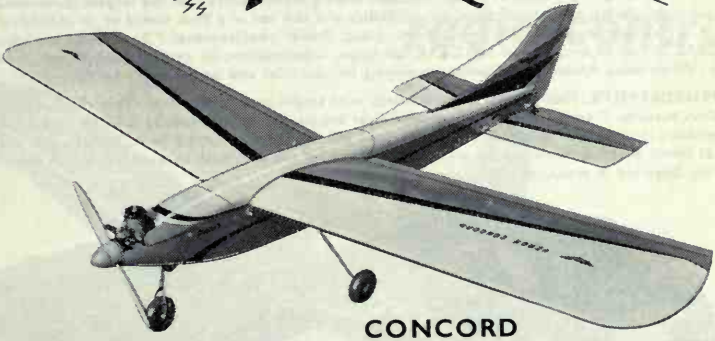

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For 4 to 10 Channel Multi-Radio control, intermediate and advanced Multi-Design. Fully prefabricated, span 66 in. For motors 5 to 10 c.c. Price £11.15.6 inc. P.T.

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VERON are the distributors for the fantastic range of **WEBRA** Diesels and Glow-motors.—See your Dealer for Details.

MODEL AIRCRAFT (B'mth) LTD., NORWOOD PLACE, BOURNEMOUTH

"CLIMAX"

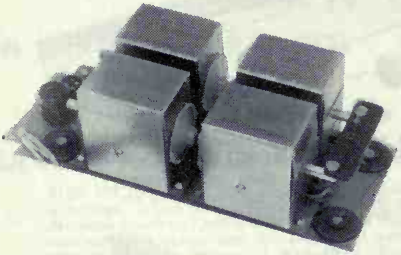
MULTI-CHANNEL TRANSISTORISED ACTUATORS

Dear Modeller,

We are frequently asked by you which type of actuator to use with various types of multi-equipment and offer the following information as a guide. Firstly, the amplifier used is completely "fail safe" (i.e. both channels can conduct at once with no damage). It does not require a centre tapped battery. There are only four wires to be connected, one to positive, one to negative and the other two to the respective reeds. The common side of the reed unit should be connected to the negative of the actuator supply. All British Rx's bring a wire out from the common side of the reed unit. American and Japanese Rx's frequently have the common side of the reed bank connected to the positive. This should be disconnected and a wire brought out and connected as above.

The **SERVOMITE:** Very light and small actuator with adequate power for the largest competition aircraft. It requires insulating against vibration for reliability and the use of a Pack board or an individual vibration mount is recommended. Transit time approx. ½ sec. Power requirements 7·2v. DEACs are essential. Use 225 DEAC for small aircraft and 500 DEAC for large. Consumption on average load 300mA. Reed current 10mA. When using American equipment requiring 6v. use 7·2v. and tap off at 6v. for Rx.

The **MUSCLEMITE:** Heavier and larger actuator with ample reserve of power. Very reliable due to built-in vibration mounts. Transit time ⅜ sec. approx. Power requirements 6v. enabling it to be used with American Rx. without tapping. Consumption on average load 250mA. Reed current 8·5mA. Switching board has extra land at limits enabling more movement to be obtained for the spin with an external switch coupled to the throttle. Supplied in made-up or kit form.



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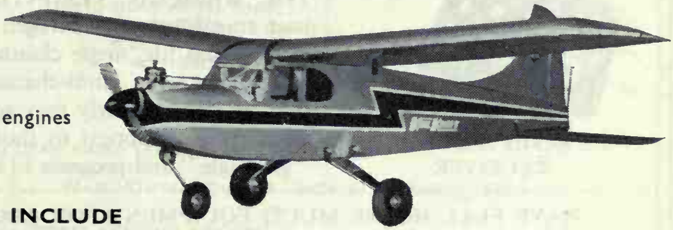

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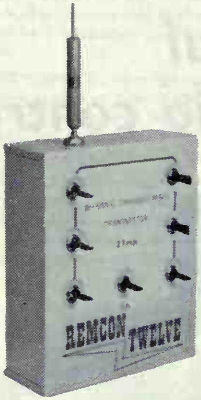
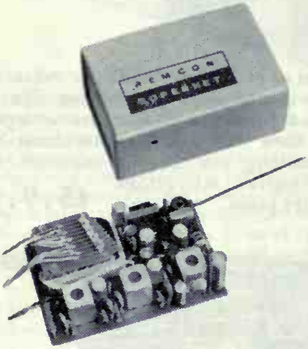


REMCON TWELVE TRANSMITTER



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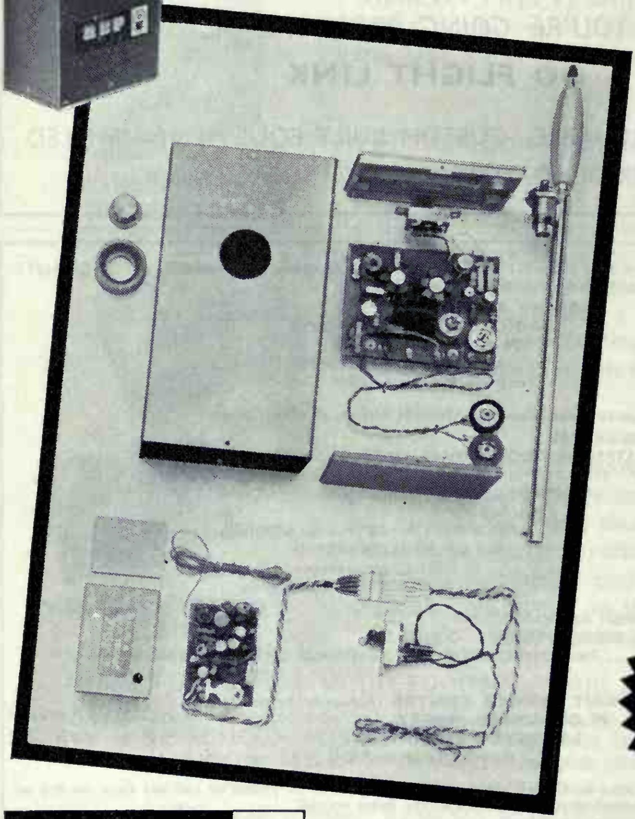

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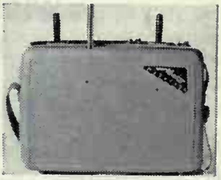

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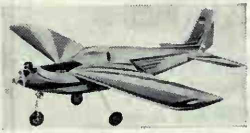

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